

SECTION 00 01 10 – TABLE OF CONTENTS

DIVISION 00 – PROCUREMENT AND CONTRACTING REQUIREMENTS

Section 00 01 10 Table of Contents

DIVISION 01 – GENERAL REQUIREMENTS

Section 01 10 00 General Requirements
Section 01 25 00 Substitution Procedure
Section 01 26 00 Contract Modification Procedures
Section 01 29 00 Application for Payment
Section 01 31 00 Project Management and Coordination
Section 01 32 00 Construction Progress Documentation
Section 01 32 33 Photographic and Video Recording Documentation
Section 01 33 00 Submittals
Section 01 40 00 Quality Requirements
Section 01 42 00 References
Section 01 50 00 Temporary Facilities and Controls
Section 01 60 00 Product Requirements
Section 01 73 00 Execution
Section 01 73 29 Cutting and Patching
Section 01 77 00 Project Closeout
Section 01 78 23 Operation and Maintenance Data
Section 01 78 39 Project Record Documents
Section 01 79 00 Demonstration and Training

DIVISION 03 – CONCRETE

Section 03 10 00 Concrete Forming and Accessories
Section 03 20 00 Concrete Reinforcing
Section 03 30 00 Cast-In-Place Concrete

DIVISION 05 – METALS

Section 05 12 00 Structural Steel Framing
Section 05 31 00 Steel Decking
Section 05 40 00 Cold-Formed Metal Framing
Section 05 50 00 Metal Fabrications
Section 05 51 19 Metal Grating Stairs
Section 05 53 13 Bar Gratings

DIVISION 06 – WOODS, PLASTICS, AND COMPOSITES

Section 06 10 00 Rough Carpentry
Section 06 41 00 Architectural Wood Casework
Section 06 61 00 Simulated Stone Fabrications

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

Section 07 21 00 Thermal Insulation
Section 07 72 00 Roof Accessories

Section 07 84 00 Firestopping
Section 07 92 00 Joint Sealants

DIVISION 08 – OPENINGS

Section 08 11 13 Hollow Metal Doors and Frames
Section 08 11 14 Stainless Steel Doors and Frames
Section 08 31 00 Access Doors and Panels
Section 08 33 23 Overhead Coiling Doors
Section 08 33 24 Rapid Roll-up Doors
Section 08 71 00 Door Hardware
Section 08 80 00 Glazing

DIVISION 09 – FINISHES

Section 09 21 16 Gypsum Board Assemblies
Section 09 30 00 Tiling
Section 09 51 00 Acoustical Ceilings
Section 09 65 00 Resilient Flooring
Section 09 67 00 Resinous Flooring
Section 09 68 13 Tile Carpeting
Section 09 91 23 Interior Painting
Section 09 96 00 High-Performance Coatings

DIVISION 10 – SPECIALITIES

Section 10 14 00 Signage
Section 10 21 13.13 Metal Toilet Compartments
Section 10 22 13 Wire Mesh Partitions
Section 10 28 00 Toilet Room Accessories
Section 10 44 00 Fire Protection Specialties
Section 10 51 13 Metal Lockers

DIVISION 13 – SPECIAL CONSTRUCTION

Section 13 21 13 Clean Room Pass-Thru Air Shower

DIVISION 21 – FIRE SUPPRESSION

Section 21 13 00 Fire Suppression

DIVISION 22 – PLUMBING

Section 22 05 00 Basic Plumbing Material and Methods
Section 22 05 53 Identification for Plumbing Piping and Equipment
Section 22 07 00 Plumbing Insulation
Section 22 11 29 Plumbing System Pumps
Section 22 20 00 Building Plumbing Services Piping
Section 22 34 00 Domestic Water Heaters
Section 22 40 00 Plumbing Fixtures and Equipment

DIVISION 23 – HEATING VENTILATING AND AIR CONDITIONING

Section 23 05 00	Basic Mechanical Materials and Methods
Section 23 05 48	Mechanical Sound and Vibration Control
Section 23 05 53	Identification for Mechanical Piping, Ductwork, and Equipment
Section 23 05 93	Testing, Adjusting, and Balancing
Section 23 07 00	HVAC Insulation
Section 23 08 16	Commissioning of HVAC Systems
Section 23 20 00	Building HVAC Services Piping
Section 23 21 16	Hydronic Piping Specialties
Section 23 21 23	Hydronic Pumps
Section 23 22 16	Steam and Condensate Heating Piping Specialties
Section 23 25 00	Water Treatment Systems
Section 23 25 33	HVAC Water Filtration Equipment
Section 23 31 13	Ducts and Duct Accessories
Section 23 33 30	Duct Silencers
Section 23 34 16	Fans
Section 23 37 13	Air Outlets and Inlets
Section 23 37 23	HVAC Gravity Ventilators
Section 23 57 00	Heat Exchangers
Section 23 64 16	Liquid Water Chillers
Section 23 65 13	Packaged Cooling Towers
Section 23 73 13 13	Indoor Basic Air Handling Units
Section 23 73 13	Air Rotation Units
Section 23 73 43 19	Outdoor Custom Air Handling Units
Section 23 81 26	Split-System Air-Conditioners
Section 23 82 19	Fan Coil Units
Section 23 82 39	Unit Heaters

DIVISION 25 – INTEGRATED AUTOMATION

Section 25 00 00	Chiller Plant Control System
Section 25 00 10	Hot Water Skid Control System
Section 25 00 20	Air Handlers Control System

DIVISION 26 – ELECTRICAL

Section 26 00 50	Common Work Results for Electrical
Section 26 05 19	Low-Voltage Electrical Power Conductors and cables
Section 26 05 26	Grounding and Bonding for Electrical Systems
Section 26 05 29	Hangers and Supports for Electrical Systems
Section 26 05 33.13	Conduits for Electrical Systems
Section 26 05 33.16	Boxes and Covers for Electrical Systems
Section 26 05 44	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
Section 26 05 53	Identification for Electrical Systems
Section 26 05 73.13	Short-Circuit Studies
Section 26 05 73.16	Coordination Studies
Section 26 05 73.19	Arc-Flash Hazard Analysis
Section 26 09 23	Lighting Control Devices
Section 26 22 13	Low-Voltage Distribution Transformers
Section 26 24 13	Switchboards
Section 26 24 16	Panelboards
Section 26 25 00	Low-Voltage Enclosed Bus Assemblies

Section 26 27 26	Wiring Devices
Section 26 28 13	Fuses
Section 26 28 16	Enclosed Switches and Circuit Breakers
Section 26 29 13.03	Manual and Magnetic Motor Controllers
Section 26 33 00	Heat Tracing
Section 26 33 23.11	Central Battery Equipment for Emergency Lighting
Section 26 43 13	Surge Protective Devices for Low-Voltage Electrical Power Circuits
Section 26 51 19	LED Interior Lighting
Section 26 52 13	Emergency and Exit Lighting

DIVISION 27 - COMMUNICATIONS

Section 27 05 26	Grounding and Bonding for Communication Systems
Section 27 05 28	Pathways for Communication Systems
Section 27 05 29	Hangers and Supports for Communication Systems
Section 27 05 36	Cable Trays for Communication Systems
Section 27 11 00	Communication Equipment Room Fittings
Section 27 11 16	Communication Racks, Frames, and Enclosures
Section 27 13 13	Communications Copper Backbone Cabling
Section 27 13 23	Communications Optical Fiber Backbone Cabling
Section 27 15 13	Communications Copper Horizontal Cabling
Section 27 21 33	Data Communications Wireless Access Points

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

Section 28 05 13	Conductors and Cable for Electronic Safety
Section 28 05 14	Fire Alarm Cables and Conductors
Section 28 05 28	Conductors and Pathways for Electronic Safety
Section 28 13 00	Alarm and Access Control
Section 28 23 00	VSS and CCTV
Section 28 31 11	Digital Addressable Fire Alarm System

SECTION 01 10 00 – GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Project information
 - 2. Work covered by the Contract Documents.
 - 3. Work phases.
 - 4. Products ordered in advance.
 - 5. GPO-furnished products.
 - 6. Contractor's use of GPO premises.
 - 7. Occupancy requirements.
 - 8. Contractor hours of operation.
 - 9. Specification formats and conventions.
 - 10. Planning and scheduling utility outages.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for limitations and procedures governing temporary use of the GPO's facilities.

1.3 PROJECT INFORMATION

- A. Project Identification: U.S publishing Office; SID Building D Press Room Renovation
- B. Project Location: 735 N. Capitol St, NE, Washington, DC 20002
- C. Owner: U.S. Government Publishing Office
- D. Contractors Owner Representative: Thomas Simescu
- E. Engineer: MEP and FP, Henry Adams, 600 Baltimore Avenue, Baltimore, MD 21204
- F. Engineering Consultants:
 - 1. Architect: ARCADIS, 630 Plaza Drive, Suite 100, Highlands Ranch, CO 80129
 - 2. Structural: Woods-Peacock, 5285 Shawnee Road, Suite 100, Alexandria, VA 2231
 - 3. IT/Security/Acoustical: Polysonics, 405 Belle Air Lane, Warrenton, VA 20186
 - 4. Environmental: Jenkins, 8600 La Salle Road, York building, Suite 509, Towson, MD 21286
 - 5. Cost Estimating: Rider-Levett-Bucnall, 9881 Broken land Parkway, Suite 101, Columbia,

MD 21046.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. Program Identification: Construction services associated with the GPO Long-term Re-development.
- B. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following items:
 - 1. Renovation of the 3rd floor of Building D, that include HVAC, Plumbing, FP, Electrical, Architectural and Structural for the incorporation of an ISO7 Clean Room, manufacturing space, waste destruction space, mechanical/electrical support spaces, and other office type support spaces to be located on the 3rd floor.
 - 2. Replacement of existing air-cooled chilled water system with a water-cooled chilled water system.
 - 3. Replacement of Basement HVAC in Building D.
 - 4. Replacement of 2nd Floor HVAC in Building D.
 - 5. Support for relocating/removal existing air compressors located in the Basement of Building D.

1.5 WORK PHASES

- A. Work phasing plans and information will be provided with contract award.
- B. Work phasing plans and information that are provided are not intended to restrict the Contractor to this specific phasing. The Contractor may submit a re-phasing schedule at no additional cost to the GPO for review and written approval.
- C. Schedule the execution of the Work according to the phasing sequence indicated and to avoid interference with normal functions of the GPO.
- D. Before commencing the Work of each phase, submit a schedule to the COR showing the sequence, the commencement and completion dates, and the move-out and move-in dates of personnel for the various phases of the Work.
- E. On completion, each phase of the Work shall be fully operational.

1.6 PRODUCTS ORDERED IN ADVANCE BY THE GPO

- A. General: The GPO may negotiate Purchase Orders with Suppliers of material and equipment to be incorporated into the Work. The GPO may assign these Purchase Orders to the Contractor. Information regarding such Purchase Orders will be provided with each Task Order. Costs for receiving, handling, storage, and protection if required, and installation of material and equipment are to be included in the Task Order Price:
 - 1. The Contractor's responsibilities are the same as if the Contractor had negotiated the Purchase Orders, including responsibility to renegotiate the purchase and to execute final Purchase-Order agreements.

2. The Schedule of Products Ordered in Advance by the GPO will be provided with each Task Order.

1.7 GPO FURNISHED PRODUCTS

- A. The GPO may furnish products to the Contractor for incorporation into the Work. Information regarding such products will be provided with each Task Order. Costs for receiving, handling, storage, and protection if required, and installation of the products are to be included in the Task Order Price. The following apply to GPO furnished products:
 1. The GPO will arrange for and deliver Shop Drawings, Product Data, and Samples to the Contractor.
 2. The GPO will arrange and pay for the delivery of GPO-furnished products.
 3. Upon delivery, the GPO will inspect the products for damage. The Contractor is to be present for and assist with the inspection.
 4. If the GPO-furnished products are found to be damaged, defective, or missing at the time of delivery and inspection, the GPO will arrange for repair or replacement.
 5. The GPO will arrange for manufacturer's field services and for delivery of manufacturer's warranties to the Contractor for incorporation in the Warranty Manual.
 6. The GPO will furnish the Contractor the earliest possible delivery date for GPO-furnished products. Using the GPO-furnished earliest possible delivery dates, the Contractor is to designate the delivery date(s) for the GPO-furnished items in the Contractor's CPM Schedule.
 7. The Contractor is to review the Shop Drawings, Product Data, and Samples and return them to COR noting discrepancies or anticipated problems in use of the product.
 8. The Contractor is responsible for receiving, unloading, and handling GPO-furnished items at the Jobsite or other agreed to delivery location. Upon inspection and acceptance, the responsibility for the products will be assigned to the Contractor by the GPO using a materials transfer form, with signatures by authorized representatives of the GPO and the Contractor.
 9. The Contractor is responsible for protecting GPO-furnished items from damage during storage and handling, including damage from exposure to the elements.
 10. The Contractor is to repair GPO-furnished items that are damaged as a result of Contractor's operations. Repair or replacement is at the Contractor's expense.

1.8 CONTRACTOR'S USE OF GPO PREMISES

- A. Contractor Use of the Jobsite: The Contractor's use of premises is limited to work in the areas indicated in each Task Order. Do not disturb areas, facilities or operations beyond the Jobsite designated for the Work.
 1. Limits: Confine constructions operations to the areas indicated in each Task Order.
 2. GPO Occupancy: Allow for the GPO's occupancy and use of all areas that are not designated and authorized for the Contractor's construction operations.
 3. The Contractor shall have full use of the Jobsite designated for construction operations within the limits indicated for each Task Order during the construction period, within the hours indicated, and as directed by the COR. The Contractor's use of the Jobsite is limited by the GPO's right to perform work or to retain other contractors on portions of Program.
 4. Driveways and Entrances: Keep entrances serving premises clear and available to the GPO, the GPO's employees, tenants, and emergency vehicles at all times. Do not use

driveways and entrances for parking or storage of materials.

- a. Schedule deliveries to minimize use of driveways and entrances.
 - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.
- B. Utilize areas designated for Contractor staging, storage, and parking, as indicated.
- C. Use of Existing Buildings: Maintain existing buildings in a weather tight condition throughout the construction period. The Contractor is responsible for the repair of all damage caused by the Contractor's construction operations, to include approval and acceptance by the GPO. The Contractor is to protect the premises and their occupants during the construction period.

1.9 OCCUPANCY REQUIREMENTS

- A. Full GPO Occupancy: The GPO and/or its tenants will occupy the site and existing buildings during the entire construction period. The Contractor is to cooperate with the GPO during construction operations to minimize conflicts and facilitate the GPO usage, and perform the Work so as not to interfere with day-to-day GPO operations.

1.10 CONTRACTOR HOURS OF OPERATION

- A. Contractor Working Hours: The Contract Work is subject to the schedule requirements and GPO operational restrictions, which will be provided with each Task Order. The Work may require that the Contractor's staff and operate extended and or multiple shifts, such days, nights, weekends and holidays. The Contractor is to notify the COR a minimum of 24-hours in advance of any change to the Contractor's daily work plan.

1.11 SPECIFICATION FORMATS AND CONVENTIONS

- A. Specification Format: With the exception of federal standard specifications and specifications will be organized into Divisions and Sections using the CSI/CSC's "MasterFormat" numbering system.
- B. Section Identification: The Specifications use Section titles to help with cross-referencing in the Contract Documents. Sections are in numeric sequence; however, the sequence is incomplete as all available Sections and Section numbers are not used and the CSI numbering system is not sequentially complete. Consult the table of contents at the beginning of the specifications for each Task Order to determine the numbers and names of sections in the applicable Construction Documents.
- C. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
 - 1. Abbreviated Language: Language used in the Specifications is abbreviated. Interpret singular words as plural, and plural words as singular where applicable as the context of the Contract Documents indicates. Refer any questions to the COR in writing for determination.

2. Imperative mood and streamlined language are used in these Specifications. This imperative language is directed to the Contractor, unless specifically noted otherwise. Requirements expressed in the imperative mood are to be performed by the Contractor. Occasionally, the indicative or subjunctive mood may be used in the Section Text for clarity to describe responsibilities that must be fulfilled indirectly by the Contractor or by others when so noted.
3. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.

1.12 PLANNING AND SCHEDULING UTILITY OUTAGES

- A. Prior to any utility outage/interruption, prepare a plan and schedule of such outage. Include the outage schedule duration, identification of the service affected, temporary utility service to be provided, identification of available service alternative, and the action to be taken in any emergency. Apply for all outages of utility systems in writing. Fully coordinate outage requests with COR. Obtain approval in writing from the GPO. Schedule all outages at least three (3) weeks in advance with a 96-hour notification provided by the Contractor confirming date, time, and duration. Outages will normally be scheduled on the weekends – Saturday and Sunday.
- B. Provide a suction/pump truck during all sanitary sewer line outages to support the disabled lift stations. Transport sewage to alternate lift stations located on the GPO and dispose of in accordance with GPO procedures. Provide a suction/pump truck with a minimum capacity of 3,000 gallons or greater.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 SCHEDULE OF PRODUCTS ORDERED IN ADVANCE

- A. TBD

END OF SECTION 01 10 00

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for substitutions.

1.3 DEFINITIONS

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor:
 - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - 2. Substitutions for Convenience: Changes proposed by Contractor or GPO that are not required in order to meet other Project requirements but may offer advantage to Contractor or GPO.

1.4 SUBMITTALS

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
- B. Substitution Request Form: Request a copy from the COR.
- C. A/E Action: If necessary, A/E will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. A/E will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later:
 - 1. Forms of Acceptance: Change Order, Construction Change Directive, or A/E Supplemental Instructions for minor changes in the Work.
 - 2. Use product specified if A/E does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution

with related products and materials. Engage qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

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

PART 2 PRODUCTS

2.1 SUBSTITUTIONS

- A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
 - 1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, A/E will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
 - b. Substitution request is fully documented and properly submitted.
 - c. Requested substitution will not adversely affect Contractor's construction schedule.
 - d. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - e. Requested substitution is compatible with other portions of the Work.
 - f. Requested substitution has been coordinated with other portions of the Work.
 - g. Requested substitution provides specified warranty.
 - h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B. Substitutions for Convenience: A/E will consider requests for substitution if received within 60 days after the Notice to Proceed. Requests received after that time may be considered or rejected at discretion of A/E.
 - 1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, A/E will return requests without action, except to record noncompliance with these requirements:
 - a. Requested substitution offers GPO a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities GPO must assume.
 - b. Contractor shall compensate A/E for any costs incurred for redesign and evaluation services related to the request for substitution.
 - c. Requested substitution does not require extensive revisions to the Contract Documents.
 - d. Requested substitution is consistent with the Contract Documents and will produce

- indicated results.
- e. Substitution request is fully documented and properly submitted.
 - f. Requested substitution will not adversely affect Contractor's construction schedule.
 - g. Requested substitution has received necessary approvals of authorities having jurisdiction.
 - h. Requested substitution is compatible with other portions of the Work.
 - i. Requested substitution has been coordinated with other portions of the Work.
 - j. Requested substitution provides specified warranty.
 - k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 3 EXECUTION (Not Used)

END OF SECTION 01 25 00

SECTION 01 26 00 - CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for handling and processing Contract modifications.

1.3 MINOR CHANGES IN THE WORK

- A. A/E will issue supplemental instructions authorizing Minor Changes in the Work, not involving adjustment to the Contract Sum or the Contract Time, on "A/E's Supplemental Instructions" form.

1.4 PROPOSAL REQUESTS

- A. GPO-Initiated Proposal Requests: A/E will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications:
 - 1. Proposal Requests issued by A/E are for information only. Do not consider them instructions either to stop work in progress or to execute the proposed change.
 - 2. Within time specified in Proposal Request after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change:
 - a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 - b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 - c. Include costs of labor and supervision directly attributable to the change.
 - d. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
- B. Contractor-Initiated Proposals: If latent or unforeseen conditions require modifications to the Contract, Contractor may propose changes by submitting a request for a change to A/E.
 - 1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the

- proposed change on the Contract Sum and the Contract Time.
2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
 3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
 4. Include costs of labor and supervision directly attributable to the change.
 5. Include an updated Contractor's Construction Schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
 6. Comply with requirements in Division 01 Section "Product Requirements" if the proposed change requires substitution of one product or system for product or system specified.

C. Proposal Request Form: Use Document for Proposal Requests provided by A/E.

1.5 CHANGE ORDER PROCEDURES

- A. On GPO's approval of a Proposal Request, A/E will issue a Change Order for signatures of GPO and Contractor.

1.6 CONSTRUCTION CHANGE DIRECTIVE

- A. Construction Change Directive: A/E may issue a Construction Change Directive which instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.
1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.
- B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.
- C. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01 26 00

SECTION 01 29 00 – APPLICATION FOR PAYMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.
- B. Coordinate the Schedule of Values and Applications for Payment with the Task Order CPM Schedule, List of Subcontracts, and Submittal Log.
- C. Related Sections include the following:
 - 1. Division 01 Section “Construction Progress Documentation” for administrative requirements governing preparation and submittal of the Contractor’s CPM Schedule and Submittals Schedule.
 - 2. Division 01 Section “Project Closeout” for submittal of items required before final payment.
 - 3. Division 01 Section “Project Record Documents” for procedural requirements governing the submission of Project Record Documents.
 - 4. Division 01 Section “Operation and Maintenance Data” for submittal of items required before final payment.

1.3 DEFINITIONS

- A. Schedule of Values: A written statement furnished by the Contractor allocating the entire Task Order Price to the various portions of the Work for that Task Order and once accepted by the Contracting Officer, to be used as the basis for reviewing the Contractor’s Applications for Payment. Notwithstanding the foregoing, the Construction Services General Conditions Fee, and the incentive amount, if any, earned under the Contract, shall be shown as separate line items in the Schedule of Values. A separate Schedule of Values shall be furnished by the Contractor for each construction services Task Order.

1.4 SCHEDULE OF VALUES

- A. Coordination: Coordinate the preparation of the Schedule of Values with the preparation of the Contractor’s CPM Schedule.
 - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
 - a. Application for Payment forms with Continuation Sheets.

- b. Submittals Schedule.
 - c. Contract CPM Schedule.
 - d. List of products.
 - e. List of principal Suppliers and fabricators.
 2. Submit the Schedule of Values to Contracting Officer at earliest possible date, but no later than 14 calendar days after receiving the Task Order.
 3. The cost-loaded CPM Schedule will satisfy the requirements for the Schedule of Values.
 4. Sub-schedules: Where the Work is separated into phases requiring separately phased payments, provide sub-schedules showing values correlated with each phase of payment.
- B. Format and Content: Use the Construction Work Package Specifications table of contents as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Specification Section. Format and content are to be per AIA Document G703, Application and Certificate for Payment – Continuation Sheet, or equivalent:
 1. Identification: Include the following information on the Schedule of Values:
 - a. Contract number and name.
 - b. Task order number and name.
 - c. Contractor's name.
 - d. Date of submittal.
 2. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:
 - a. Related Specification Section or Division.
 - b. Description of the Work.
 - c. Name of Subcontractor.
 - d. Name of manufacturer or fabricator.
 - e. Name of Supplier.
 - f. Task Order number and Contract Modification(s) that affect the schedule of values.
 - g. Dollar value.
 - h. Percentage of the Task Order Price to the nearest one-hundredth percent, adjusted to total 100 percent.
 3. Provide a breakdown of the Task Order Price in enough detail to facilitate continued evaluation of the Applications for Payment and progress reports. Coordinate with the Construction Work Package Specifications table of contents. Provide several line items for principal subcontract amounts, where appropriate. Include separate line items under required principal subcontracts for the following items.
 4. The value assigned to the total of these line items shall be a minimum of 5 percent of the Task Order Price:
 - a. Start-up and commissioning activities.
 - b. Operation and Maintenance manuals.
 - c. Punch list activities.
 - d. Project Record Documents.
 - e. Warranties.
 - f. Demonstration and training.
 5. Round amounts to nearest whole dollar. Total shall equal the Task Order Price.

6. The Contractor shall include all test and inspection activities in its CPM schedule and establish a Schedule of Values for all required QC documentation, all tests and inspection activities, reports, and procedures required in the Construction Documents on a Section by-Section basis. Additionally, the Contractor shall include a pay line item specifically for Quality activities and QC Organizational personnel.
7. Provide a separate line item in the Schedule of Values for each part of the Work where Application for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
8. Differentiate between potential items stored on-site and items stored off-site. Include evidence of insurance or bonded warehousing if required.
9. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
10. Include a separate line item in the Schedule of Values for the Construction Services General Conditions Fee.
11. Each item in the Schedule of Values and Application for Payment shall be complete as a requirement for payment.
12. Schedule of Values Updating: Update and resubmit the Schedule of Values with the next Applications for Payment when Contract Modifications result in a change in the price of a Task Order.

1.5 APPLICATION FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Contracting Officer Representative and paid for by the GPO.
 1. Each Application for Payment shall be sub-divided by Task Order.
 2. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.
- B. Payment Application Times: Application for Payment shall coincide with the monthly update of the Contractor's CPM schedule. The period covered by each Application for Payment starts on the day following the end of the preceding period and shall not exceed one calendar month, unless otherwise approved by COR.
- C. Payment Application Forms: Use forms provided by the Contracting Officer for the Application for Payment. The format and content are to be per AIA Document G702, Application and Certificate for Payment, or equivalent.
- D. Application Preparation: Complete every entry on the forms. Notarize and execute by a person authorized to sign legal documents on behalf of the Contractor. The GPO will return incomplete applications without action:
 1. Entries shall match data on the Schedule of Values and the Contractor's CPM Schedule. Use updated schedules if revisions were made.
 2. Include amounts of Contract Modifications issued before last day of the construction period covered by application.
 3. Transmittal: Submit the Application for Payment as indicated in Contract, each signed and notarized. Include waivers and releases of liens and claims and other attachments.
 4. Transmit Applications for Payment with a transmittal form listing attachments and recording appropriate information about application in a manner acceptable to the Contracting Officer.

- E. Waivers and Releases of Liens and Claims.
- F. Waivers and releases of liens and claims on forms provided or approved by the GPO, shall be signed by the Contractor and each Subcontractor, Sub-subcontractor and Supplier
- G. Initial Application for Payment: Administrative actions and submittals that shall precede or coincide with submittal of the first Application for Payment for each Task Order include the following:
 - 1. List of Subcontractors.
 - 2. Schedule of Values.
 - 3. Contractor's CPM Schedule (preliminary if not final).
 - 4. Schedule of unit prices.
 - 5. Submittals Schedule (preliminary if not final).
 - 6. List of Contractor's staff assignments.
 - 7. List of Contractor's principal consultants.
 - 8. Copies of the building permit.
 - 9. Copies of authorizations and licenses from authorities having jurisdiction for performance of the Work.
 - 10. Initial progress report.
 - 11. Meeting minutes for the pre-construction conference.
 - 12. Performance and payment bonds.
 - 13. Initial settlement survey and damage report.
 - 14. Submittal and approval of the Contractor's Safety Plan.
 - 15. Submittal and approval of the Contractor's Quality Control Plan.
 - 16. Invoice Attachment Forms, of the Contract.
- H. Monthly Application for Payment: Administrative actions and submittals that shall accompany the submittal of the Contractor's monthly Application for Payment for each Task Order include the following:
 - 1. Schedule of Values.
 - 2. Subcontractor Payment Form.
 - 3. Monthly Progress Report, prepared according to requirements specified in Division 01 Section "Construction Progress Documentation."
 - 4. Evidence of payment for material on-site if reimbursement for such material that is being requested.
 - 5. Update of Contract Record Documents.
 - 6. Monthly Quality Control Summary Report, prepared according to requirements specified in Division 01, Section 014000, Paragraph 1.7.B.13.
 - 7. Interim waivers and releases of liens and claims.
- I. Application for Payment at Substantial Completion: After issuance of the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
 - 1. Include documentation supporting claim that the Work or portion thereof, is substantially complete.
 - 2. This application shall reflect Certificates of Partial Substantial Completion issued previously for GPO occupancy of designated portions of the Work, if applicable.
 - 3. Advise the COR of change-over in security provisions.

- J. Final Payment Application: Submit the final Application for Payment for a Task Order, and the overall Contract, with final waivers and releases of liens and claims, and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
1. Evidence of completion of the closeout requirements.
 2. Insurance certificates for products and completed operations where required and proof that taxes, fees, and similar obligations were paid.
 3. Updated final statement, accounting for final changes to the Task Order Price.
 4. Evidence that claims have been settled.
 5. Final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion or when the GPO took possession of and assumed responsibility for corresponding elements of the Work.
 6. Final, liquidated damages settlement statement.
 7. Return of all GPO identification badges and keys.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01 29 00

SECTION 01 31 00 - PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative provisions for coordinating construction operations including, but not limited to, the following:
 - 1. General project coordination procedures.
 - 2. Coordination drawings.
 - 3. Requests-for-Information (RFI's)
 - 4. Project meetings:
 - a. Pre-award conference for review of Task Order proposals.
 - b. Pre-construction conference.
 - c. Pre-installation conference.
 - d. Progress meetings.
 - e. Project Closeout Meeting.
- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Requirements" for administrative and procedural requirements for the Contractor to provide and maintain an effective Quality Control Program.
 - 2. Division 01 Section: "Execution" for the coordination of general installation and field engineering services, including establishment of benchmarks and control points.
 - 3. Division 01 Section "Project Closeout" for coordinating Contract closeout.

1.3 COORDINATION

- A. Coordination: Coordinate construction operations included in various Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
 - 1. Prepare Coordination Drawings and submit to the COR.
 - 2. Coordinate installation of the Work to ensure maximum performance and accessibility for required operation, service, maintenance, and repair. The Contractor has the sole responsibility to coordinate the Work, to include instances where specific dimensions are not indicated or where the Construction Documents are schematic in nature, as is the case with most Electrical, Mechanical and Special Systems Drawings.
 - 3. Schedule construction operations in the sequence required to obtain the best results where installation of one element of the Work depends on installation of other elements, before

- or after its own installation.
 - 4. Make adequate provisions to accommodate items scheduled for later installation, and for delivery and installation of oversized equipment.
 - 5. Prepare memoranda for distribution to each party involved, outlining required coordination procedures and actions. Include such items as required notices, construction access, preparatory work, building code requirements, installation tools and equipment, utility connections and service, inspections, testing, etc.
- B. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work and completion within the specified Time of Performance. Such administrative activities include, but are not limited to, the following:
- 1. Schedule of Values preparation
 - 2. CPM Schedule preparation and updates
 - 3. Project Meetings planning, participation and documentation
 - 4. Submittals preparation and processing
 - 5. Materials Management
 - 6. Requests for Information (RFI) preparation and processing
 - 7. Jobsite management
 - 8. GPO and Jobsite Security
 - 9. Survey, layout and field engineering
 - 10. Utilities management
 - 11. Environmental coordination
 - 12. Safety Program development and administration
 - 13. Quality Control Program development and administration
 - 14. Systems start-up and commissioning
 - 15. Project closeout administration
 - 16. Application for Payment
- C. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.
- D. Prepare and submit a list of salvaged materials and equipment for turnover to the GPO.
- E. Temporary Utility Outages: Comply with requirements in Division 01 Section "General Requirements."

1.4 SUBMITTALS

- A. Coordination Drawings: Before the start of construction activities, prepare Coordination Drawings for areas with limited space availability that necessitate maximum utilization of space for efficient installation of different components, and areas requiring coordination for installation of products and materials fabricated by separate entities:
- 1. Indicate relationship of components shown on separate Shop Drawings.
 - 2. Indicate all dimensions provided on the Construction Documents and make specific note of dimensions that appear to be in conflict with submitted equipment, minimum clearance requirements, amounts of equipment and material to be installed, or other requirements. Provide alternate sketches for resolution of such conflicts to the COR for review.
 - 3. Indicate required installation sequences.

4. Comply with requirements contained in Division 01 Section "Submittals."
 5. Prepare coordination drawings of involved trades in a scale of not less than 1/4 inch = 1 foot or larger for integration of different construction elements. Show sequences and relationships of separate components to avoid conflicts in use of space. Any Work installed prior to review of coordination drawings will be at the Contractor's risk and subsequent relocation require to avoid interference shall be made at no additional cost to the GPO.
- B. Key Personnel Names: Prepare, provide and maintain current information for the Contractor's key personnel to include information for Subcontractors, Suppliers, vendors, manufacturers and fabricators. Include the person's name; title; assignments for the Work; email address; office and cellphone numbers; and emergency contact information.
- C. Post copies of the list at the Jobsite and keep the list current at all times.

1.5 REQUESTS FOR INFORMATION (RFIs)

- A. Procedure: Prepare and submit an RFI in the form specified when information is needed for interpretation of the Construction Documents:
1. RFIs shall originate with the Contractor. RFIs submitted by entities other than the Contractor will be returned with no response.
 2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in the Contractor's work or work of Subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Contract Name and Number.
 2. Task order Name and Number.
 3. Dates When: RFI submitted; Response Requested; and Response Provided.
 4. Name of the Contractor; the Architect-Engineer; and the GPO.
 5. Names and signature blocks for the individuals requesting and responding to the RFI for the Contractor, the Architect-Engineer, and the GPO.
 6. RFI number, numbered sequentially.
 7. RFI subject summary description.
 8. RFI request detailed request to include specification and drawing references, applicable field conditions and dimensions, and proposed or suggested solution(s).
 9. Attachments and references.
 10. Contractor's statement that the RFI does not involve an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the Work under the Contract.
- C. Software-Generated RFIs: All RFI's are to be submitted electronically using the GPO provided Oracle Primavera Unifier project management system. The COR's response will be transmitted to the Contractor through Unifier. Identify each RFI attachment with reference to the RFI number:
1. Attachments shall be electronic files in Adobe Acrobat PDF format.
 2. RFI must be signed and scanned for electronic transmission.
- D. COR's Action: The COR will review each RFI, determine action required, and return the RFI to

the Contractor with a response. Allow a minimum of five (5) business days for the COR's response to each RFI. Response times will vary dependent upon the complexity, completeness and nature of the RFI, and the number of RFI's being reviewed. RFIs received after 1:00 p.m. will be considered as received the following business day:

1. The following RFIs will be returned without action:
 - a. Requests for approval of submittals.
 - b. Requests for approval of substitutions.
 - c. Requests for information already indicated in the Contract Documents.
 - d. Requests for interpretation of the Architect-Engineer's actions on submittals.
 - e. Incomplete RFIs or RFIs with errors.
 2. The COR's action may include a request for additional information, in which case the COR respond period will re-start upon receipt of the revised RFI.
 3. An RFI response will not result in a change to the Contract Documents; however, if the Contractor believes an RFI response warrants an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the Work, the Contractor shall comply with Contract requirements.
- E. On receipt of COR's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify the COR within five (5) business days if the Contractor disagrees with response.
- F. RFI Log: The Contractor is to prepare, maintain, and submit a tabular log of RFIs organized by RFI number. Submit the RFI Log to the COR and Architect-Engineer on a weekly basis with Open RFIs highlighted. The RFI Log is to include the following as a minimum:
1. Contract name and number.
 2. Task order name and number.
 3. Names of the Contractor; Architect-Engineer; and the GPO.
 4. RFI number including RFIs that were cancelled or not used.
 5. Contractor cross-reference number(s).
 6. RFI subject summary description.
 7. Dates When: RFI Submitted; Response Requested; and Response Provided.
 8. RFI Status: Open; Closed; Pending; Cancelled; and Contractor statement as to whether the RFI is expected to result in an increase in the Contractor's cost of, or the time required for, the performance of any part of the Work (Yes / No).

1.6 PROJECT MEETINGS

- A. Pre-Award Conference(s) for Review of Task Order Proposals:
1. General: At the request of the Contracting Officer, a pre-award conference with the Contractor will be held before approval and award of a Task Order. The Pre-award conference agenda items include: the Contractor's understanding of the Construction Documents and contractual requirements; the Contractor's Task Order proposal; the proposed Contractor staffing and general conditions; the Contractor management plans for safety, quality, schedule and cost control; the subcontracting plan; Subcontractor qualifications and staffing; the Subcontractor work plan; permitting and special conditions; and coordination requirements. The Architect-Engineer may participate in the pre-award

- conference.
2. Minutes: The Contractor will draft meeting minutes for the pre-award conference for review and comment by the GPO and the Architect-Engineer. The Contractor will revise and re-distribute the meeting minutes to reflect comments. The pre-award conference minutes, once approved, are to be jointly signed by the Project Manager and the GPO Contracting Officer.
 3. Attendees: Contracting Officer, COR, GPO staff, Architect/Engineer, the Contractor and its key personnel nominated for assignment to the Task Order, and major Subcontractors if so requested by the Contracting Officer. The Contracting Officer will chair the pre-award meeting.
 4. Additional Factors: Additional factors that could affect award include, but are not limited to, the following:
 - a. Provision and acceptability of payment and performance bonds.
 - b. Safety record.
 - c. Quality-control experience and expertise.
 - d. Percentage of work performed by own forces.
 - e. Contractor's experience with similar work.
 - f. Capabilities of the Contractor's proposed Project Scheduler.
 - g. Financial standing of the Contractor.
 - h. Mobilization plan.
 - i. Understanding the physical constraints at the GPO as associated with this Work
 - j. Equipment and manpower availability.
 - k. Pricing information.
 5. Representations and commitments made by the Contractor or its Subcontractors as documented in the Pre-Award Conference minutes shall be construed as binding on the Contractor.
- B. Pre-construction Conference:
1. General: The Contractor will arrange a Pre-Construction Conference as indicated in Contract.
 2. Minutes: The Contractor will draft meeting minutes for the Pre-Construction Conference for review and comment by the GPO. The Contractor will revise and re-distribute the meeting minutes to reflect comments. The Pre-Construction Conference minutes, once approved, are to be jointly signed by the Project Manager and Project Manager, and the GPO COR. The Pre-Construction Conference minutes are to be distributed to all attendees and other relevant parties.
 3. Pre-Construction Conference Agenda Items: Identify and discuss items of significance that could affect progress:
 - a. Introductions:
 - 1) Conference attendees.
 - 2) GPO Organization Overview.
 - 3) Architect-Engineer Organization Overview.
 - 4) Contractor's Organization and Key Personnel Other Involved Organizations.
 - b. Overview of the Task Order:
 - 1) Scope of work.

- 2) Time of Performance.
 - 3) Liquidate damages clause Construction Documents.
- c. LDBE/MBE/WBE participation and certifications.
- d. Insurance Program.
- e. GPO Security Requirements:
 - 1) Construction Activity at the GPO Areas.
 - 2) Badging (identification; GPO access; authorization to escort; authorization to drive on the GPO area) – requirements and process Vehicle requirements for operation on the GPO.
- f. GPO Operations Center:
 - 1) Advance work planning coordination.
 - 2) Daily work planning and briefing information.
 - 3) Communications protocol and requirements.
 - 4) Crane operation / height GPO flagman training Approved.
 - 5) Construction Documents to be on site for Code Inspections.
 - 6) Permitting for Temporary Facilities.
 - 7) Limitations on use of the site.
 - 8) Requirements for maintenance of the site.
- g. GPO Construction Safety & Environmental Program Requirements Review of the GPO construction safety policy Review of the primary safety requirements:
 - 1) Testing and Remediation requirements for lead paint, asbestos, PCB's and petroleum contaminated soils.
 - 2) Personal Protective Equipment (PPE).
 - 3) Burn Permits & Fire Preventions.
 - 4) Fall protection.
 - 5) Trench safety.
 - 6) Confined Space.
 - 7) Lock-out-Tag-out Procedures.
 - 8) Construction Barriers.
 - 9) Housekeeping.
- h. GPO Construction Quality Control Program Requirements:
 - 1) Review of the construction quality control requirements.
 - 2) Testing and Inspection Requirements.
 - 3) Survey Requirements.
 - 4) Utility Locating Requirements.
- i. Contractor's Construction Management & Operational Activities Preliminary construction schedule:
 - 1) Mobilization.
 - 2) Work Phasing.
 - 3) Working hours.
 - 4) Critical work sequencing.
 - 5) Designation of key Jobsite personnel.

- 6) Site Management: staging; storage; employee parking and transportation; deliveries and hauling; temporary services.

j. Construction Administration Procedures:

- 1) Change Order Process.
- 2) Contract Modification Process.
- 3) Construction Management Information System.
- 4) Correspondence.
- 5) Contractor's Daily Reports.
- 6) Contractor's Monthly Reports.
- 7) Schedule of Values.
- 8) CPM Schedule.
- 9) Project Meetings.
- 10) Submittals.
- 11) RFI's.
- 12) Materials management.
- 13) Jobsite management.
- 14) Survey, layout and field engineering.
- 15) Utilities locating, outage requests and work planning.
- 16) Systems start-up and commissioning.
- 17) Punch list preparation and update.
- 18) Project Close-out.
- 19) Application for Payment.

- k. Refer to Contract required submittals due at the pre-construction conference.

C. Quality Control Meetings

1. The Contractor is to conduct Quality Control meetings in accordance with the requirements of Section 014000 Quality Requirements. The GPO staff and or the Architect-Engineer may attend.

D. Weekly Progress Meetings:

1. General: The Contractor is to conduct progress meetings at regularly scheduled times. Progress meetings are to be held weekly with a length of approximately 1-hour. Where practical and with approval of the COR, the frequency of the progress meetings may be once-every-two-weeks. Progress meetings are in addition to specific meetings held for other purposes, such as coordination and quality control meetings. Discussions will address administrative and technical issues of concern, the process and timeline for determining resolutions, and review of the Contractor's ongoing and upcoming activities.
2. Minutes: The Contractor is to draft meeting minutes for each Progress Meeting and distribute electronically to all attendees, other relevant parties and the Program Team. Comments and corrections to the weekly progress meeting minutes are to be included as an attachment to the minutes, and included in the minutes of the next meeting as applicable. The Progress Meeting minutes are to be signed by the Contractor's Project Manager.
3. Attendees: The Contractor's Project Manager and key support staff are to attend the progress meetings. The GPO staff will attend the progress meetings, and the Architect-Engineer may attend.
4. Agenda: Note any comments or corrections to the previous progress meeting minutes.

Review items of significance that could affect progress, or disrupt or interfere with ongoing GPO Operations. Include topics for discussion as appropriate to status of Task order. Review the status and identify action items for coordination and control of the Work to include:

- a. Safety:
 - 1) Current issues list, incidents and accident reports.
 - 2) Update of monthly work-hours, recordable and lost time injuries.
 - 3) Job Hazard Analysis (JHA) prepare for near term activities.
 - 4) MOT planning Safety personnel status.
- b. OCIP
 - 1) Enrollment list status.
 - 2) On-site Subcontractor list Claims.
- c. Security:
 - 1) Badges.
 - 2) Escorting.
 - 3) AOA vehicles and drivers Access Gate procedures.
- d. Site Management:
 - 1) Delivery and Hauling Activities.
 - 2) Housekeeping & Site Maintenance.
- e. Environmental Program:
 - 1) Storm-water protection.
 - 2) Abatement and removal activities.
 - 3) Site coordination, testing, inspection, reporting.
- f. Contractor's CPM Schedule:
 - 1) Update the overall status of work (number of days ahead or behind schedule).
 - 2) Provide the status of schedule update submittals required for compliance with the Construction Progress Documentation specification; and Identify planning and coordination requirements for current and near-term activities assessment.
 - 3) Review the Contractor's three-week look ahead schedule
- g. Quality Control Program:
 - 1) Organization updates.
 - 2) Reporting status.
 - 3) Testing and inspection.
 - 4) Quality control meetings.
 - 5) Quality control inspections.
 - 6) Deficiency list update.
 - 7) Non-compliance Notice update.

h. Work Coordination:

- 1) Building Code Inspections.
- 2) Building Code Special Inspections Utility Locating.
- 3) Utility Outages and work planning.
- 4) Notifications and other coordination Permits.
- 5) Submittals.
- 6) Submittal log Hot List items.

i. RFI's

- 1) RFI log review Hot List items.

j. Materials Management.

k. Change Management:

- 1) Change order log.
- 2) Contract Modifications.

l. Project Close-out Activities:

- 1) Substantial Completion.
- 2) Punch list.
- 3) Warranties.
- 4) Final Cleaning.
- 5) Operations and Maintenance Data.
- 6) Record Drawings.
- 7) Demonstration and Testing.

5. Submit at the weekly progress meeting, a three-week look-ahead schedule. This schedule shall include a four-week period, one week showing actual progress from the previous week and three weeks showing planned work for the three weeks after the meeting date. Include in the schedule all activities in sufficient detail as approved by COR. Submit a list of Subcontractors identifying dates of when Subcontractors will be on-site or working at off-site fabrication plants.
6. CPM Schedule Updating: Revise the CPM Schedule for work plans and sequences established and agreed upon at progress meetings. Issue revised schedules concurrently with the report of each meeting

E. Task Order Closeout Meetings:

1. General. The Contractor is to conduct Task Order Closeout Meetings starting no later than ninety (90) calendar days prior to the Scheduled Substantial Completion Date for each Task Order.
2. Minutes: The Contractor is to draft meeting minutes for the Closeout Meetings and submit for review and comment by the GPO and the Architect-Engineer. The Contractor is to revise and re-distribute the meeting minutes to incorporate the comments. The Closeout Meeting minutes are to be signed by the Contractor's Project Manager and Quality Control Manager and distributed to all attendees and other relevant parties.
3. Attendees: The Contractor and its key personnel responsible for the Task Order closeout; major Subcontractors; Suppliers; and other concerned parties as needed shall attend the meeting. The GPO staff and the Architect-Engineer may attend the Close-out meetings.

4. Agenda: Review the Task Order Closeout Requirements and prepare a log listing each delivery item for Closeout to include: the required action and current status; due dates; the staff assigned responsibility for each Closeout requirement, and the applicable Subcontractors, Suppliers, fabricators and manufacturers or that are involved General requirements for Task Order Closeout include:
 - a. Requirements and Procedures for Substantial Completion.
 - b. Requirements and Procedures for Final Completion and Acceptance.
 - c. Completion Inspections: punch-list; pre-final and final acceptance.

- F. Punch List preparation; correction of Punch List items; and updating of the Punch List through to the Final Completion and Acceptance Inspection.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01 31 00

SECTION 01 32 00 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies administrative and procedural requirements for various CPM schedules and reports required for proper performance of the Work.
- B. For the purpose of payment, costs incurred by the Contractor to correctly implement and update the project schedule will be valued at 2% of the Task Order Price in the Schedule of Values. Payment will be applied by prorating the amount on a monthly basis from NTP to Substantial Completion of the Task Order.
- C. The Contractor is to prepare a CPM schedule for each Construction Work Package based on the Notice to Proceed, the Scheduled Substantial Completion Date, the Scheduled Final Completion Date, and any required interim milestones described in the Task Order for the Construction Work Package. Schedule deliverables and products include:
 - 1. Preliminary 90-day, cost-loaded CPM Schedule and related narrative, which will be kept current as basis for monthly progress reports until such time as the detailed Progress Baseline CPM Schedule is approved by the GPO.
 - 2. Construction Progress Baseline CPM Schedule in CPM format, with cost and resource loading, and all related narrative and cash flow projection curves.
 - 3. Monthly Updates of the CPM Schedule in CPM format, with cost and resource loading, and all related narrative and cash flow projection curves.
 - 4. Submittals Schedule.
 - 5. Schedule of Tests and Inspections.
 - 6. Record, As-Built CPM Schedule.
- D. Reports required include the following:
 - 1. Daily Construction Reports.
 - 2. Material Location Reports.
 - 3. Field Correction Reports.
 - 4. Special Reports.
 - 5. Monthly Progress Reports.
 - 6. Quality Control Reports.
- E. Related Sections include the following:
 - 1. Division 01 Section "Application for Payment" for Schedule of Values.
 - 2. Division 01 Section "Project Management and Coordination" for Project meeting minutes.
 - 3. Division 01 Section "Quality Requirements" for test and inspection reports.

4. Division 01 Section "Product Requirements" for Product List.

1.3 DEFINITIONS

- A. Activity: The fundamental unit of work in a project plan and schedule. Each activity has defined geographical boundaries and a detailed estimate of resources required to construct the task. Each activity is assigned a unique description, activity number, activity codes, and dollar value.
- B. Cost Loading: The allocation of the Schedule of Values for the completion of an activity as scheduled. The sum of costs for all activities shall equal the Task Order Price.
- C. CPM Network: The structure of the schedule. The network is the representation that defines the construction logic in terms of all the activities with their logical dependencies.
- D. CPM Schedule: A cost- and resource-loaded CPM schedule covering the entire Time of Performance.
- E. Critical Path: The critical path is the longest connected chain of interdependent activities in a CPM network that impacts the completion of the Work.
- F. Excusable Delay: Refer to the Contract.
- G. Predecessor Activity: An activity that precedes another activity in the network.
- H. Preliminary CPM Schedule: A CPM schedule covering all activities to be started and/or completed within the first 90 days of the Construction Work Package.
- I. Resource Loading: The allocation of manpower and equipment necessary for the completion of an activity as scheduled.
- J. Successor Activity: An activity that follows another activity in the network.
- K. Time of Performance: The total time allotted in a Task Order for a Construction Work Package to achieve Final Completion of that Construction Work Package.
- L. Total Float: The amount of time an activity can be delayed from its earliest start date without delaying the end of the Work covered by the applicable schedule.
 - 1. Float time is not for the exclusive use or benefit of either the GPO or the Contractor, but is a jointly owned, expiring Program resource available to both parties as needed to meet specific schedule milestones, and the completion date set for the Construction Work Package.
 - 2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

1.4 PLANNING

- A. The Contractor shall prepare a detailed construction schedule for each Construction Work Package, and is responsible to plan, schedule and progress the Work in compliance with the requirements of the Contract Documents.

- B. Failure to include any work item required for performance of the Work shall not excuse the Contractor from completing all Work within applicable completion dates.
- C. Failure of the Contractor to comply with these schedule requirements may be considered cause for withholding progress payments or termination for default.

1.5 SUBMITTALS

- A. General: The Contractor shall provide all schedule submittals on computer disk media as well as tabular printouts, resource curves and histograms, and 24-by-36-inch time-scaled logic diagrams. The Contractor shall also submit an electronic file ("XER") of the CPM Schedule with a unique name on a CD-ROM disc. The latest version of Primavera P6 Professional Project Management scheduling software shall be used. All costs incurred by the Contractor to correctly implement, computerize and update the CPM Schedule shall be borne by the Contractor. The number of copies of each submittal shall be as described in this Section or as may be requested by COR.
- B. Preliminary CPM Schedule: The Preliminary CPM Schedule and its related narrative as described in this Section shall be submitted at the preconstruction meeting for each Construction Work Package. Within a minimum of 15 calendar days, the COR will respond with comments and the Contractor shall resubmit within 7 calendar days, if required. A Preliminary CPM Schedule is to be prepared and submitted by the Contractor for each Construction Work Package.
- C. CPM Schedule: The detailed CPM Schedule and its related narrative as described in this Section shall be submitted along with the projected cash-flow curve as early as practicable after the Notice to Proceed, but in no event later than 45 calendar days after the Notice to Proceed. Within a minimum of 15 calendar days, the COR will respond with comments and the Contractor shall resubmit within 10 calendar days, if required. A CPM Schedule is to be prepared and submitted by the Contractor for each Construction Work Package.
- D. Earning Schedule or Cash-Flow-Projection: Depicts the monthly projections generated from the CPM Schedule. The Earning Schedule or Cash Flow Projection Curve shall depict the comparison of the actual and planned progress, illustrates schedule variances graphically by plotting the budgeted cost of work scheduled (BCWS) and the budgeted cost of work performed (BCWP) and reporting the Schedule Performance Index (SPI) for the project to date. The Contractor shall report the project progress through the cut-off date.
- E. Narrative Report: Part of a Progress Report that describes, at a minimum, the Contractor's plan of operation for meeting the project milestones and the Final Completion date, a critical path analysis, a discussion of problems encountered, and proposed solution thereof, work calendars, constraints, delays experienced, and any pending Time Impact Analysis (TIA), float consumption as a result of either the GPO and/or the Contractor, documentation of and logic changes, duration changes, resource changes or other relevant changes.
- F. Daily Construction Reports: Post Daily Construction Reports to the Program Team's document control database site by noon on the following day report. Daily Progress Reports are to be prepared and submitted by the Contractor for each Construction Work Package.
- G. Monthly Progress Report: All components of the Monthly Progress Report described in this Section shall be submitted as attachments to the Contractor's monthly Application for Payment.

Monthly Progress Reports are to be prepared and submitted by the Contractor for each Construction Work Package.

- H. Record As-Built CPM Schedule: A Record Task Order CPM Schedule accurately reflecting actual progress of Work shall be submitted, as part of the Task Order Record Documents. All activities shall have actual dates that are true and accurate. Within a minimum of 15 calendar days, the COR will respond with comments and the Contractor shall resubmit within 10 calendar days, if required. Record As-Built CPM Schedules are to be prepared and submitted by the Contractor for each Construction Work Package. I. Qualification Data: For Project Scheduler.

1.6 QUALITY ASSURANCE

- A. Project Scheduler Qualifications: Minimum of three (3) years' experience as a full-time Construction Scheduler preparing and updating CPM schedules on project(s) of similar size and scope, with the capability to produce CPM reports and diagrams within 24 hours when requested. Certification as a Planning and Scheduling Professional is preferred. The Project Scheduler shall be classified as one of the Contractor's key personnel for the construction services.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 PROJECT SCHEDULER

- A. Engage a Project Scheduler, either as a Contractor's employee or as a Contractor's consultant, to provide planning, evaluation, and reporting using CPM scheduling, and to prepare required schedules.
1. The Project Scheduler shall be an active participant at all meetings related to progress, alleged delays, and time impacts.
 2. The Project Scheduler shall be available on-site full time.
 3. Time-impact analyses and special reports shall be provided at no additional cost to the GPO.

3.2 PRELIMINARY SCHEDULE

- A. The Contractor shall prepare a Preliminary Cost-Loaded CPM Schedule covering the first 90 calendar days of the Time of Performance for each Construction Work Package. The Preliminary CPM Schedule format shall be the critical path method.

The order, sequence, and interdependence of all significant work items including mobilization, demobilization, testing and commissioning, construction, procurement, fabrication, and delivery of critical or special materials and equipment; utility interruption coordination; submittals and approvals of critical Samples, Shop Drawings, procedures, or other reasonable requirements that may be required.

- B. The Preliminary CPM Schedule shall show all significant work activities that occur in the first 90

days, including planning, mobilization, procurement, fabrication, submittals, and construction. A comprehensive log of all required submittals shall accompany the Preliminary CPM Schedule. The Preliminary CPM Schedule shall also include the Contractor's conceptual plan for completion within the specified Time of Performance.

Acceptance of the cost-loaded Preliminary CPM Schedule by the COR shall not constitute acceptance of Schedule of Values for any cost-loaded activities.

C. A narrative describing the Contractor's approach to mobilization, procurement, and construction during the first 90 days shall accompany the Preliminary CPM Schedule. The narrative shall elaborate on the basis for durations, production rates, major equipment to be used, and shall identify all major assumptions used to develop the 90-day schedule.

1. The Contractor shall assign cost to construction activities on the Preliminary CPM Schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with the COR's approval, be assigned to fabrication and delivery activities. Costs shall be assigned to testing and commissioning activities, O&M manuals, Punch List activities, and Record Documents.
2. Cost coding of activities shall be coordinated with the COR.

3.3 CPM SCHEDULE

A. Scheduling Requirements: The Contractor shall prepare a CPM Schedule for each Construction Work Package. The CPM Schedule shall be a computerized cost- and resource-loaded, time scaled CPM Schedule in PDM format that includes the following:

1. The phasing, sequence, and interdependence of all significant work items as detailed in the Construction Documents including mobilization, demobilization, testing of materials and equipment, commissioning of systems, construction, procurement, fabrication, delivery and installation, any long-lead time orders for major or significant materials and equipment, utility interruption coordination, submittals and approvals of critical Samples, Shop Drawings, procedures, or other reasonable requirements that may be required.
2. Ensure that actual number of activities in the CPM Schedule is sufficient to assure adequate planning of the Work and to permit monitoring and evaluation of progress and the analysis of time impacts.
3. Work by the GPO, or utility agencies, and other third parties that may affect or be affected by the Contractor's activities.
4. Adequate referencing of all work items to identify Subcontractors or other performing parties.
5. The CPM Schedule shall comprise of a well-organized Work Breakdown Structure (WBS), the development of which is based on deliverable-oriented methodology that captures all the project activities. The Project WBS shall allow schedule summarization at a minimum of four hierarchical WBS levels, such as Project Area (Level 1), WBS Element (Level 2), Work Package (Level 3), Control level activities (Level 4).
6. Activity Coding is to be coordinated with the COR to establish minimum requirements for structure and values for the first 5 code fields. Activities in the schedule shall be sorted or grouped by project specific activity codes to reflect information related to an activity, such as Responsible Party, Phase/Stage, and Area/Location. Each activity shall be assigned a unique Activity ID Number which shall not be changed once assigned.
7. Activity durations not in excess of 14 work days, except non-construction activities such as procurement and fabrication. The Work Breakdown Structure and level of detail for

- Activities shall be coordinated in advance with the COR.
8. Activities are to be cost and resource loaded to show the direct craft man-days and major equipment required to perform the Work, including work by Subcontractors.
 9. A narrative that explains the basis for the Contractor's determination of construction logic, estimated durations, cost and resource allocations, estimated quantities and production rates, hours per shift, workdays per week, and types, numbers, and capacities of major construction equipment to be used. A listing of nonworking days and holidays incorporated into the schedule shall be provided.
- B. Critical Path Activities: The CPM Schedule shall be prepared to include the data for the total Construction Work Package and the critical path activities shall be identified, including critical paths for interim completion dates. Scheduled start or completion dates imposed on the schedule by the Contractor shall be consistent with the Scheduled Substantial Completion Dates and milestone dates established for the Construction Work Package. The CPM Schedule shall accurately show all as-built activities completed from the issuance of the Notice to Proceed up to the submittal of this schedule.
- C. Assignment of Costs to Activities for Progress Payments:
1. The Contractor shall assign cost to construction activities on the CPM Schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with the COR's approval, be assigned to fabrication and delivery activities. Costs shall be assigned to testing and commissioning activities, O&M manuals, Punch List activities, and Record Documents.
 2. Each activity cost shall reflect an accurate value subject to review and approval by COR.
 3. The total cost assigned to activities shall equal the total applicable Task Order Price.
 4. Activity cost codes shall be coordinated with the COR.
- D. Required Submittals: On a monthly basis, the Contractor shall submit three copies of each of the following components of the CPM Schedule:
1. A time-scaled plot of the schedule network in PDM format showing logic ties for all activities including submittals and procurement activities.
 2. Computer-generated CPM Schedule Reports that contain the following data for each work item: activity identification number, description, resource loading, duration, early start and early finish calendar dates, late start and late finish calendar dates, and total float in calendar days. The reports shall also show the logic ties of successor and predecessor work items. The reports shall be sorted as follows, or other sorts as required by the COR:
 - a. By activity identification.
 - b. By total float x early start.
 - c. By early start x early finish x total float.
 3. The narrative described in Subparagraph 3.3-A-9 above.
 4. A cash-flow report showing monthly expenditures projected over the Time of Performance of the applicable CPM schedule. A cumulative cash-flow curve based on early and late schedule events shall also be submitted. These reports shall be derived from the CPM Schedule.

3.4 DAILY CONSTRUCTION REPORTS

- A. Prepare and post to the Program Team's document control database site a Daily Construction Report by noon on the following day. A separate Daily Construction Report is provided for each Construction Work Package. Record the following information concerning events at the site, and coordinate with requirements in Division 01 Section "Quality Requirements:
1. Accidents and Incidents (refer to accident reports).
 2. Work Activities Performed
 3. Contractor Self Performed Work

Classification and number of employees and work hours; equipment used; materials and equipment installed.
 4. Subcontractor Work Activity

Classification and number of employees and work hours; equipment used; materials and equipment installed.
 5. Time-and-Material Work Activity Performed

Classification and number of employees; equipment used; materials and equipment installed; daily ticket for Time-and-Material work completed and signed.
 6. Unit Price Line Item Work Activity

Line-item description; location of work; and documentation for measurement and acceptance of completed unit price line items.
 7. Material and equipment deliveries

Delivery ticket documentation with verification and cross-reference to approved submittals; verification of quantity and condition of material and equipment.
 8. Hauling for Off-GPO Disposal

Documentation and manifests for type of materials removed and disposal site.
 9. On-site Construction Equipment (by Subcontractor).

Weather conditions (temperature range; precipitation; etc.) and effect on critical path activity.
 10. Other on-site activity (utility outages; surveys; utility marking and locating; testing and inspections; building code inspection; environmental remediation work performed; site meetings; third parties and visitors of note)

3.5 MATERIAL LOCATION REPORTS

- A. At monthly intervals, prepare a comprehensive list of materials delivered to and stored at the site. The list shall be cumulative, showing materials previously reported plus items recently delivered. Include with the list a statement of progress on and delivery dates for all materials or items of equipment being fabricated or stored away from the building site. Submit copies of the

list to the COR monthly as an attachment to the Application for Payment.

3.6 RFI FOR CORRECTION ACTION

- A. When the need to take corrective action that requires a departure from the Construction Documents arises, prepare a detailed report including a statement describing the problem, why the Construction Documents cannot be followed, and the recommended corrective action. Submit the report and recommended corrective action via RFI to the COR.

3.7 SPECIAL REPORTS

- A. When an event of unusual or significant nature occurs at the site, prepare and submit a special report. List the chain of events; persons participating; the response by the Contractor's personnel; an evaluation of the results or effects; and similar pertinent information. Notify the COR in advance when such events are known or predictable.

Include tabular CPM reports, time-scaled logic diagrams, resource curves and histograms, and narratives as requested by the COR.

- B. Submit special reports directly to the COR within three calendar days of an occurrence. Submit a copy to other parties affected by the occurrence.

3.8 MONTHLY PROGRESS REPORTING

- A. General: Approval of the Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly schedule update.
- B. Monthly CPM Schedule Update Meetings: Monthly schedule updates shall be the product of joint review meetings between the Contractor and the COR. The joint review shall focus on actual progress for the preceding month, planned progress for the upcoming month supported by a Contractor-prepared Four-Week Look-Ahead Schedule, impact to schedule if any due to change notices issued, adverse weather, and any effected changes to the Construction CPM Schedule. The agreed-on progress, and changes, if any, shall be incorporated into the schedule update to be submitted. The update shall always represent the actual history of accomplishment of all activities, and will form the basis for the Contractor's Application for Payment. Delay issues shall be presented for discussion and, when possible, resolution.
- C. Required Submittals: On a monthly basis, the Contractor shall submit two copies in electronic format ("XER" file) of the updated CPM schedule, and an electronic copy and two hard copies of each of the following components of the Monthly Progress Report:
 - 1. A monthly progress narrative, the content of which shall be prescribed by the COR, which shall include as a minimum a description of overall progress for the preceding month, a critical path analysis, a discussion of problems encountered and proposed solution thereof, delays experienced and proposed recovery measures, a monthly reconciliation of weather impact, the status and impact of contract modifications, documentation of any logic changes, and any other changes made to the schedule since the previous monthly update.
 - 2. CPM schedule reports listing completed activities, activities in progress, and remaining activities in the format requested by COR. For each activity, the Contractor shall provide

- those details identified in Subparagraph 3.3-D-2 of this Section.
3. Monthly and cumulative cash-flow curves that show the actual vs. planned cash-flow status.
 4. Documentation of delivered material in the form of paid invoices or other evidence that the Contractor has clear title for the material delivered.
- D. If critical activities of the schedule are delayed and such delay is not excusable as defined in the Contract, the remaining sequence of activities and/or duration thereof shall be adjusted by the Contractor through such measures as additional manpower, additional shifts, or the implementation of concurrent operations until the schedule produced indicates Work will be completed on schedule.
- E. The monthly schedule update shall form the basis for the Contractor's Application for Payment. The progress payment for an activity shall be based on its agreed-on percentage of completion. For unit-priced line items, the approval of the Contractor's monthly requisition is contingent on the submittal of a satisfactory monthly schedule update and documentation that substantiates the actual quantity of completed and accepted units of work.

3.9 DELAYS AND REQUESTS FOR EXTENSION OF TIME

- A. The determination for an extension of time will be made by the Contracting Officer according to Articles 13 and 29 of the Contract.
- B. If the Contractor seeks an extension of time, it must, among other things, prepare a Time Impact Analysis (TIA) showing the impact to critical path activities on the CPM network at the time of the delay.
- C. An electronic copy and two (2) hard copies of each TIA Report together with an electronic file (XER file) of the CPM Schedule Impact Analysis shall be submitted to the GPO in accordance with the Contract and these specifications.
- D. Upon approval, a copy of the TIA signed by the GPO COR will be returned to the Contractor, and incorporated in to the next Baseline CPM Schedule Update. A TIA related to GPO directed change shall be incorporated into and attached to the corresponding Contract Modification.
- E. Anticipated Adverse Weather:
 1. The following number of days of adverse weather are anticipated for each month for each calendar year as follows:
 - a. January - 7.
 - b. February - 5.
 - c. March - 6.
 - d. April - 6.
 - e. May - 8.
 - f. June - 6.
 - g. July - 6.
 - h. August - 7.
 - i. September - 5.
 - j. October - 5.
 - k. November - 5.

I. December - 6.

2. Those adverse weather days shall not constitute Excusable Delay or otherwise entitle the Contractor to an extension of time or any other relief.
3. The number of actual adverse weather days shall be calculated chronologically from the first to the last day in each month. A day shall not be considered an adverse weather day unless adverse weather prevents the Contractor from progressing critical path activities for 50 percent or more of the workday. In preparing the CPM Schedule, the Contractor shall reflect the above anticipated adverse weather days on all weather-dependent activities. Weather-caused delays shall not result in any additional compensation to the Contractor.
4. On days where adverse weather is encountered, the Contractor shall list all critical activities under progress and shall indicate the impact adverse weather had, if any, on the progress of such activities. This information shall be presented at the end of the adverse weather day to the COR or its authorized representative for its review and approval.
5. If the Contractor is found eligible for an extension of time for a Construction Work Package, the Contracting Officer will issue a modification reflecting such extension. The extension of time will be made on a calendar day basis.

F. Required Notifications and Submittals:

1. Provide a time-impact analysis that illustrates the impact during the update period in which the event occurred, that the event has been mitigated to the greatest possible extent, and that the event still impacts overall completion of the applicable Construction Work Package.
2. Include with the request, two copies of the impacted schedule submittal, in electronic format, and photocopies of all relevant documents that support the request.
3. Provide required notifications and submittals within the contractually required time periods.
4. Expiration of time periods without providing the required notice or submittal for a delay or impact shall constitute forfeiture of the Contractor's rights with respect to that delay or impact.

G. Revision to the Progress Baseline CPM Schedule

1. If the GPO believes that the Progress Baseline CPM Schedule needs a specific revision either in logic, activity duration, manpower or cost, the GPO will request in writing that the Contractor makes such revision. The Contractor shall make such revisions within seven days of receiving the GPO request. At no time shall the Contractor include in the Progress Baseline CPM Schedule Updates an item to which the GPO disagrees.
2. In the event of GPO directed change or a delay event affecting the Scheduled Substantial Completion Date, the Baseline CPM Schedule is to be revised and submitted to the GPO for approval.

3.10 RECORD AS-BUILT CPM SCHEDULE

- A. Upon completion of each Construction Work Package and as a condition of final payment for that Construction Work Package, the Contractor shall submit an electronic copy and two (2) hard copies of a Record As-Built CPM Schedule showing actual start and finish dates for all work activities and milestones, based on the accepted monthly updates. These schedule submittals shall be in tabular and in time-scaled PDM plot formats.

END OF SECTION 01 32 00

SECTION 01 32 33 - PHOTOGRAPHIC AND VIDEO RECORDING DOCUMENTATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for the following:
 - 1. Preconstruction photographs and video recordings.
 - 2. Photographic and video recordings of key construction activities.
 - 3. Daily and monthly construction photographs and video recordings.
 - 4. Video recording of Demonstration and Training
 - 5. Final Completion construction photographs.
- B. Related Sections include the following:
 - 1. Division 01 Section 01 "Submittals" for submitting construction photographs.
 - 2. Division 01 Section 01 "Quality Requirements" for photographic and video-recording of daily site activities and key construction activities.
 - 3. Division 01 Section 01 "Project Closeout" for submitting photographic documentation as Project Record Documents at Project closeout.
 - 4. Division 01 Section 01 "Demonstration and Training" for submitting videotapes of demonstration of equipment and training of GPO's personnel.

1.3 SUBMITTALS

- A. Qualification Data: Submit the name, position, qualifications, and sample photos and videos taken by individuals proposed to be assigned responsibility for photographic and video recording documentation.
- B. Quality Control Plan: Include the processes, procedures and requirements for photographic and video recording documentation in the Quality Control Plan.
- C. File Naming Convention: Submit the proposed file naming convention for photographs and video recordings.
- D. File Delivery and Storage Format: Submit the proposed file delivery and storage format and method for photographs and video recordings. The photographic and video recording storage format is to be capable of sorting and searching based on: date of the photograph or recording; the location of the work; and the work activity.
- E. Key Plan: Submit a key plan including a description of each work area with notation for location and direction of photographs and video recordings. Indicate elevation or story of construction.

F. Digital Photographs:

1. Submit all digital photographic image files within five (5) business days of taking photographs via Unifier, or other delivery and storage format as approved by the COR.
2. Monthly Submittal: Each month, submit two copies of a DVD containing all photographic documentation for the month and a copy of the updated tracking log for photographs.
3. Required photographic documentation: The minimum requirements for photographic documentation are:
 - a. Pre-construction conditions for each work area.
 - b. Key construction activities.
 - c. Daily progress of the work with focus on critical activities.
 - d. Conditions at the time of Final Completion or portion thereof.

G. Video Recordings (Contractor to obtain approval of GPO Security before conducting a video recording, Consult with COR before any video recording):

1. Submit all video recording documentation within five (5) business days of taking video recordings via two (2) copies of a DVD, or other delivery and storage format as approved by the COR.
2. Monthly Submittal: Each month, submit an updated log documenting all video recordings, to include: the date of the video recording; the location; the work activity; the video recorder's name; and the Contractor's name, contract number and Task Order number.
3. Required video recording documentation: The minimum requirements for video recording documentation are:
 - a. Pre-construction conditions for each work area.
 - b. Key construction activities.
 - c. Weekly progress of the work with focus on critical activities.
 - d. Demonstration and training provided for the GPO operations and maintenance personnel.
 - e. Conditions at the time of Final Completion for each Construction Work Package or portion thereof.

H. Consolidated File of Photographic and Video Recordings at Final Completion: The Contractor shall catalog and provide a complete set of all photographs and video recordings upon Final Completion.

1.4 USAGE RIGHTS

- A. Transfer copyright usage rights from the photographers and video recorders to the GPO for unlimited reproduction of photographic and video recording documentation.

PART 2 PRODUCTS

2.1 PHOTOGRAPHIC AND VIDEO RECORDING DOCUMENTATION A (If permitted and approved).

A. Digital Images:

1. Digital Camera: Minimum sensor resolution of eight (8) megapixels.
2. Format: Provide color images in JPG format with minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped.
3. Date and Time Stamp: Each photographic is to be date and time stamped to show when the photograph was created.
4. File Name: Each photograph file is to be named with reference to:
 - a. Date the photograph was created.
 - b. Location.
 - c. Work area and activity.
 - d. Name of the photographer.
 - e. Name of the Contractor, contract number and Task Order number.
5. Tracking log: Develop and maintain a tracking log for all photographs, to include: the date of the photograph; the location; work activity; the photographer's name; and the Contractor's name, contract number and Task Order number.

B. Video Recordings:

1. Provide high-resolution, color, digital video recordings in DVD format, or other delivery and storage format as approved by the COR.
2. Narrative: Provide verbal, narrative description to accompany the video recording.
3. Organization and Identification: On each DVD, provide a label printed directly on the DVD with the following information:
 - a. Date video recording was recorded.
 - b. Location.
 - c. Work activity
 - d. Duration of the recording in minutes and seconds.
 - e. Name of the video recorder.
 - f. Name of the Contractor, contract number and Task Order number.
- g. Tracking log: Develop and maintain a tracking log for all video recordings, to include: the date of the video recording; the location; work activity; the video recorder's name; and the Contractor's name, contract number and Task Order number.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The Quality Control Manager shall be responsible for the provision of the required photographic and video recording documentation. The processes, procedures and requirements for photographic and video recording documentation shall be detailed in the Quality Control Plan. The requirements, status and work planning for provision of the required photographic and video recording documentation shall be provided to the GPO during the regularly scheduled Quality Control briefings. Key construction activities that require photographic and or video recording are to be identified and reviewed at the Quality Control briefings with the GPO.
- B. Key Construction Activities: Key construction activities to be documented using photographs and or video recordings include, but are not limited to activities such as: foundations; structural

steel; concrete placement; plumbing; electrical wiring and equipment; glass and curtain-walls; roofing and waterproofing; maintenance of traffic; temporary facilities; and other activities of major significance.

3.2 PHOTOGRAPHIC DOCUMENTATION

- A. Digital Images: Submit digital images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
- B. Preconstruction Photographs: Before starting mobilization, demolition or construction, take color photographs of each work area and surrounding properties from a variety of vantage points:
 - 1. Provide a minimum of twenty (20) photographs to show existing conditions at each work area before starting the work.
 - 2. Provide a minimum of twenty (20) photographs of existing buildings and facilities adjacent to the work area to accurately record the physical conditions before starting work.
- C. Photographs of Key Construction Activities: Provide a minimum of twenty (20) photographs for each key construction activity showing all aspects of the work.
- D. Daily Site Photographs: Provide a minimum of ten (10) site photographs daily to illustrate the status and progress of work activities with focus on critical activities.
- E. Monthly Construction Photographs: Provide a minimum of twenty (20) site photographs to illustrate the overall status and progress of the work.
- F. Final Completion Construction Photographs:
 - 1. Provide a minimum of twenty (20) photographs upon Final Completion or portion thereof to show final conditions.
 - 2. Provide a minimum of twenty (20) photographs of existing buildings and facilities adjacent to the work area to accurately record the physical conditions upon completion of the work.

3.3 VIDEO RECORDINGS - GENERAL

- A. Recording: Use a tripod-mounted and or a handheld video recorder to document site conditions, progress, status of work, key construction activities, and demonstration and training. Display continuous running time, and date and time stamp each recording. At the start of each video recording, record the date, time, the location, the work activity, the person performing the video recording, the name of the Contractor, the contract number, the Task Order number, and the weather conditions to include the temperature reading at the jobsite.
- B. Narration: Describe scenes on video recordings by audio narration as the video recording is recorded. Include a description of items being viewed, recent events, and planned activities. Describe the vantage point, indicating location, direction (by compass point), and elevation or story of construction.

3.4 VIDEO RECORDINGS

- A. Preconstruction Video Recording: Before starting mobilization, demolition or construction, record with video each work site and surrounding facilities from a variety of vantage points:
 - 1. Show existing conditions adjacent to the work site before starting the work.
 - 2. Show existing buildings either on or adjoining the jobsite to accurately record the physical conditions prior to the start of demolition and construction.
- B. Video Recording of Key Construction Activities: Provide a video recording for each key construction activity showing all aspects of the work.
- C. Weekly Video Recording: Provide a weekly video recording to illustrate the status and progress of work activities with focus on critical activities.
- D. Video Recording for Demonstration and Training: Provide video recordings of the demonstration and training of the GPO's operations and maintenance personnel as required by Specification Section 01 79 00.
- E. Final Completion Video Recording: Provide a video recording upon Final Completion or portion thereof to show final conditions of the completed work, the adjacent buildings and facilities, and any adjacent work that is in progress.

END OF SECTION 01 32 33

SECTION 01 33 00 - SUBMITTALS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals. B. Related Sections include the following:
 - 1. Division 01 Section "Application for Payment"
 - 2. Division 01 Section "Construction Progress Documentation"
 - 3. Division 01 Section "Photographic and Video Recording Documentation"
 - 4. Division 01 Section "Quality Requirements"
 - 5. Division 01 Section "Project Closeout" for submitting warranties.
 - 6. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
 - 7. Divisions 03 through 28 Sections for specific requirements for submittals in those Sections.

1.3 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires the COR's responsive action.
- B. Informational Submittals: Written information that does not require the COR's approval. Submittals may be rejected for not complying with requirements.
- C. Program Management Software system: Oracle Primavera Unifier is a Web-based software service that the GPO requires the Contractor and the Architect-Engineer use on this contract as the Program Management Software system. Oracle Primavera Unifier is to be used for Submittals, to include the transmittal, distribution, log, and management of the submittals process.

1.4 SUBMITTAL PROCEDURES

- A. General: The COR will arrange for delivery of an electronic copy of the CADD drawing files for the Task Order to the Contractor at or in advance of the Pre-Construction Conference for use in preparing submittals.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities:
 - 1. Coordinate each submittal with coordination drawings, purchasing, fabrication, testing,

- delivery, other submittals, and related activities.
 - 2. Coordinate and package submittals together for related parts of the work so processing will not be delayed where submittals must be reviewed concurrently.
 - 3. The GPO reserves the right to withhold action on any submittal that requires coordination with other submittals until related submittals are received. Withholding action in this manner shall not warrant a claim by the Contractor for additional time or cost.
- C. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation" for the submittals and time requirements for scheduled performance of related construction activities.
- D. Contractor Responsibilities: The Contractor is responsible for the scheduling and submission of all submittals to the COR utilizing the Program Management Software system designated by the COR.
- E. A submittal response from the COR will not result in a change to the Contract; however, if the Contractor believes a submittal response warrants an increase or decrease in the Contractor's cost of, or the time required for the performance of any part of the work, the Contractor shall comply with Contract.
- F. Processing Time: The Contractor is to allow adequate time for submittal review, including time for re-submittals, as listed below. Time for review shall commence on the date submitted by the Contractor. Late transmittal of submittal review responses shall not warrant a claim by the Contractor for additional time or cost:
- 1. Submittal Review: Allow a minimum of 15 calendar days for review of each submittal. Response times will vary dependent upon the complexity, completeness and the nature of the submittal, the number of submittals being reviewed, and the number of persons involved in the review. Allow a minimum of 45 calendar days for submittals related to fire-detection systems and fire-protection systems.
 - 2. Sequential Review: Where sequential review of submittals by the COR, or other parties is indicated, allow a minimum of 21 calendar days for the review of each submittal. Identification: Place a permanent label or title block on each submittal for identification.
 - 3. Indicate the name of the firm or entity that prepared each submittal on the label or the title block.
 - 4. Provide a space approximately 6 by 8 inches on the label or beside the title block to record the Contractor's review and approval markings and action taken by the COR and the Architect-Engineer.
 - 5. Include the following information on the label for processing and recording action taken:
 - a. Contract Name and Number.
 - b. Task Order Name and Number.
 - c. Submittal number or other unique identifier, including revision identifier.
 - 6. Submittal number shall use Specification Section number followed by a dash and then a sequential number (e.g., 061000-001 or 070150.19-001). Re-submittals shall include an alphabetic suffix after another dash (e.g., 061000-001-A or 070150.19-001-A).
 - a. Number and title of appropriate Specification Section.
 - b. Date.
 - c. Transmittal number.
 - d. Name and address of the Contractor.

- e. Name and address of Subcontractor, if applicable.
 - f. Name and address of Supplier, if applicable.
 - g. Name of manufacturer, if applicable.
 - h. Name and address of Architect/Engineer.
 - i. Drawing number and detail references, as appropriate.
 - j. Location(s) where product is to be installed, as appropriate.
 - k. Contractor's statement that the submittal does not involve an increase or decrease in the Contractor's cost of, or the time required for, the performance of any part of the work under the Contract.
 - G. Resubmissions: The re-submittal procedure shall follow the same procedures and same number as the initial submittal with the following exceptions:
 - 1. The transmittal shall contain the same information as the first transmittal and the submission number shall indicate second, third, etc., submission. The drawing number/description shall be identical to the initial submission and the date shall be the revised date for that submission.
 - 2. No new material shall be included on the same transmittal for a resubmission.
 - 3. COR rejection shall not warrant a claim by the Contractor for additional time or cost.
 - H. Deviations: Highlight, encircle, or otherwise specifically identify deviations from the Contract Documents on submittals. Where significant deviations from the Contract Documents exist, follow the guidelines set forth in Division 01 Section "Product Requirements" for substitutions.
 - I. Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from the Contractor to the COR using the Oracle Primavera Unifier Web services. The Contractor must use the GPO provided web-based Oracle Primavera Unifier project management system (Unifier) to transmit each submittal to the COR. Response of the COR's submittal review and action will be transmitted to the Contractor through Unifier. The COR will return submittals, without review, when received from sources other than the Contractor.
 - J. Transmittal Form: Use transmittal forms and follow other submittal procedures according to information contained in the "Contractor's Administrative Information and Procedures".
 - K. Distribution: Furnish copies of final submittals to manufacturers, Subcontractors, Suppliers, fabricators, installers, and authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
 - L. Prints of all reviewed Shop Drawings may be made from transparencies that carry the appropriate review stamps.
 - M. Use for Construction: Use only final submittals with mark indicating "approved" by COR in connection with construction.
- 1.5 SUBMITTAL LOG
- A. Prepare a log that contains a complete listing of all submittals required by the Construction Documents and the Contract. Submit the log at the preconstruction meeting along with the Contractor's 90-day preliminary construction schedule specified in Division 01 Section "Construction Progress Documentation." Organize the submittal log by Specification Section number. Assign each submittal a sequential number for identification and tracking purposes.

- B. Coordinate the submittal log with Division 01 Section "Construction Progress Documentation." The submittal log shall be submitted for the COR's review and information. Include the following information:
1. Contract Name and Number.
 2. Task Order Name and Number.
 3. Contractor Name.
 4. Submittal unique identifier.
 5. Title of submittal/description.
 6. Scheduled date of the initial submission for each submittal.
 7. Required Date for Approval for each Submittal.
 8. Submittal Status.
 9. Review / Response Code.
 10. Drawing number reference, if applicable.
 11. Subcontractor/vendor reference.

PART 2 PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections:
1. Certification by the Quality Control Manager: The Quality Control Manager is to certify each action submittal verifying that the submittal complies with the Contract Documents.
 2. Number of Copies: Submit using the Oracle Primavera Unifier software, unless otherwise indicated.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment:
1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
 2. Mark each copy of each submittal to show which products and options are applicable.
 3. Include the following information, as applicable:
 - a. Manufacturer's written recommendations.
 - b. Manufacturer's product specifications.
 - c. Manufacturer's installation instructions.
 - d. Standard color charts.
 - e. Manufacturer's catalog cuts.
 - f. Wiring diagrams showing factory-installed wiring.
 - g. Printed performance curves.
 - h. Operational range diagrams.
 - i. Mill reports.
 - j. Standard product operating and maintenance manuals.
 - k. Compliance with recognized trade association standards.
 - l. Compliance with recognized testing agency standards.
 - m. Application of testing agency labels and seals.
 - n. Notation of coordination requirements.

4. Submit Product Data before or concurrent with Samples.
 5. Number of Copies: Submit all Product Data submittals electronically using the Oracle Primavera Unifier system. In addition, provide three copies for submittals related to fire detection systems and fire-protection systems.
 6. Do not submit Product Data until compliance with requirements of the Construction Documents has been confirmed.
- C. Shop Drawings: Prepare contract-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data:
1. Preparation: Include the following information, as applicable:
 - a. Dimensions.
 - b. Identification of products.
 - c. Fabrication and installation drawings.
 - d. Roughing-in and setting diagrams.
 - e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - f. Shop-work manufacturing instructions.
 - g. Templates and patterns.
 - h. Schedules.
 - i. Design calculations.
 - j. Compliance with specified standards.
 - k. Notation of coordination requirements.
 - l. Notation of dimensions established by field measurement.
 - m. Relationship to adjoining construction clearly indicated.
 - n. Seal and signature of professional engineer if specified.
 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than D-Size drawings at 24 by 36 inches.
 3. Number of Copies: Submit all Shop Drawing submittals electronically using the Oracle Primavera Unifier system. In addition, submit one reproducible transparency and two black-line prints for each Shop Drawing submittal. The COR will return the marked up reproducible transparency for the Contractor's distribution.
 4. Both the reproducible transparency and the prints shall bear the Contractor's approval stamp on each sheet. D.
 5. Coordination Drawings:
 - a. Coordination Drawings are Shop Drawings prepared by the Contractor that detail the relationship and integration of different construction elements that require careful coordination during fabrication or installation. Preparation of Coordination Drawings is specified in Division 01 Section "Project Management and Coordination."
 - b. Submit Coordination Drawings for integration of different construction elements. Show sequences and relationships of separate components to avoid conflicts in use of space.
- D. Samples: Submit samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.
1. Deliver all Samples to the COR. Samples that contain multiple, related components such

- as accessories are to be submitted in one package.
2. Identification: Attach a label on the unexposed side of Samples that includes the following:
 - a. Contract Name and Number
 - b. Task Order Name and Number
 - c. Sample Submittal Unique Identifier
 - d. Generic description of Sample / Product name and name of manufacturer.
 - e. Date and Transmittal Number
 - f. Name and Address of the Contractor
 - g. Name and Address of Subcontractor or Supplier, as applicable
 - h. Drawing number and detail references, as applicable
 - i. Location(s) where product is to be installed, as applicable
 3. Disposition: Maintain sets of approved samples at the Jobsite, available for quality control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set:
 - a. Samples that may be incorporated into the work are indicated in individual Specification Sections. Such samples must be in an undamaged condition at time of use.
 - b. Samples not incorporated into the work, or otherwise designated as the GPO's property, are the property of the Contractor.
 4. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 5. Number of Samples: Submit three full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. The COR will return submittal with options selected.
 6. Samples for Verification: Submit full-size units or samples of size indicated, prepared from same material to be used for the work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
 7. Number of Samples: Submit three sets of samples. The COR will retain two sample sets; and the remainder will be returned to the Contractor:
 - a. Submit a single sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
 - b. If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a sample, submit at least three sets of paired units that show approximate limits of variations.
- E. Products Schedule: For all Products, as detailed in individual Specification Sections, prepare a written summary identifying the specified products required for the work, their intended location, and the estimated quantity required. Submit the product schedule via the Oracle Primavera Unifier system. Include the following information in tabular form:
1. Contract Name and Number.

2. Task Order Name and Number.
 3. Contractor Name.
 4. Specification Section Reference and cross-reference to the submittal log.
 5. Specified Product.
 6. Location(s) for installation or use.
 7. Estimated Quantity Required.
- F. Submittals Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation."
- G. Contractor's Construction CPM Schedule: Comply with requirements in Division 01 Section "Construction Progress Documentation."
- H. Application for Payment: Comply with requirements in Division 01 Section "Application for Payment."
- I. Schedule of Values: Comply with requirements in Division 01 Section "Application for Payment."
- J. Contractor's Warranty Letter: Comply with requirements of the Contract. Provide the dates of warranty coverage and provide point of contact information for warranty service.
- K. Special Warranty Letters: Provide dates of warranty coverage and provide point of contact information for warranty service for special warranties required in Division 02 through 28 Sections.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections:
1. Certification by the Quality Control Manager: The Quality Control Manager is to certify each informational submittal verifying that the submittal complies with the Contract Documents.
 2. Number of Copies: Submit using the Oracle Primavera Unifier software, unless otherwise indicated.
 3. Test and Inspection Reports: Comply with requirements in Division 01 Section "Quality Requirements."
- B. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:
1. Name, address, and telephone number of entity performing subcontract or supplying products.
 2. Number and title of related Specification Section(s) covered by subcontract.
 3. Drawing number and detail references, as appropriate, covered by subcontract.
- C. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.
- D. Product Certificates: Prepare written statements on manufacturer's letterhead certifying that

product complies with requirements.

- E. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.
- F. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific project.
- G. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.
- H. Material Certificates: Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.
- I. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
- J. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.
- K. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
- L. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.
- M. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
- N. Research/Evaluation Reports: Prepare written evidence from a model code organization acceptable to the GPO that product complies with USBC. Include the following information:
 - 1. Name of evaluation organization.
 - 2. Date of evaluation.
 - 3. Time period when report is in effect.
 - 4. Product and manufacturers' names.
 - 5. Description of product.
 - 6. Test procedures and results.
 - 7. Limitations of use.
- O. Operations and Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements in Division 01 Section "Operation and Maintenance Data." Additional copies submitted for

Operations and Maintenance manuals will be marked with action taken and will be returned.

- P. Design Data: Prepare written and graphic information, including, but are not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.
- Q. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
1. Preparation of substrates.
 2. Required substrate tolerances.
 3. Sequence of installation or erection.
 4. Required installation tolerances.
 5. Required adjustments.
 6. Recommendations for cleaning and protection.
- R. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
1. Name, address, and telephone number of factory-authorized service representative making report.
 2. Statement on condition of substrates and their acceptability for installation of product.
 3. Statement that products at the Jobsite comply with requirements.
 4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
 5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
 6. Statement on whether conditions, products, and installation will affect warranty.
 7. Other required items indicated in individual Specification Sections.
- S. Bonds: Prepare written information indicating current status of bonding coverage. Include name of entity covered by insurance or bond, limits of the coverage, amounts of deductibles, if any and term of coverage.
- T. Manufacturers' warranties.
- U. Construction Photographs and Video-recordings: Comply with requirements in Division 01 Section "Photographic Documentation."
- V. Material Safety Data Sheets: Submit information directly to COR.

2.3 DELEGATED DESIGN

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of the Contractor by the Construction Documents, provide products and systems complying with specific performance and design criteria indicated.

- B. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to COR.
- C. Delegated-Design Schedule: For all Delegated-Design requirements, as detailed in individual Specification Sections, prepare a written summary identifying the specified delegated-design required for the work. Submit the delegate-design schedule via the Oracle Primavera Unifier system. Include the following information in tabular form:
 - 1. Contract Name and Number.
 - 2. Task Order Name and Number.
 - 3. Contractor Name.
 - 4. Specification Section Reference and cross-reference to the submittal log.
 - 5. Specified Delegated-Design requirement.
- D. Delegated-Design Submittal: Submit all delegated-design documentation, including calculations, data, reports and drawings signed and sealed by the responsible design professional licensed in Virginia. Submit delegate-design submittals electronically via the Oracle Primavera Unifier system, and provide three (3) hard copies.
- E. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include a list of codes, loads, and other factors used in performing these services.

PART 3 EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. The Contractor is to mark each submittal with an approval stamp before submitting to the COR.
- B. In checking Shop Drawings and Product Data, verify all dimensions and field conditions and check and coordinate Shop Drawings and Product Data of any Section or trade with the requirements of other sections or trades as related thereto, as required for proper and complete installation of the work.
- C. Approval: Stamp each submittal with a uniform, approval stamp. Include contract name and number, Task Order name and number, location, submittal number, section title and number, name of reviewer, date of the Contractor's approval, and a statement certifying that the submittal has been reviewed, checked, and approved for compliance with the Contract Documents, which shall include dimensions, clearances, compatibility, and coordination with Shop Drawings and Product Data submitted for other work. The Quality Control Manager is to verify and certify that each submittal complies with the Contract Documents.
- D. If the Contractor has not checked the submittals carefully, even though stamped as checked and approved, submittals shall be returned to the Contractor for proper checking before further processing or review by the COR regardless of any urgency claimed by the Contractor. In such a situation, the Contractor will be responsible for any resulting delays. Furthermore, the Contracting Officer may hold the Contractor responsible for increased GPO costs resulting from the Contractor's failure to comply with the requirements set forth herein.

3.2 COR'S ACTION

- A. General: The COR will not review submittals that do not bear the Contractor's approval stamp and will return them without action.
- B. COR Responsibilities: The review of Shop Drawings and other submittals by the COR will be for general conformance with the Contract Documents only, and the review shall not be interpreted as a checking of detailed dimensions, quantities, or approval of deviations from the Construction Documents. The COR review shall not relieve the Contractor of its responsibility for accuracy of Shop Drawings nor for the furnishing and installation of materials or equipment according to the Contract Documents.
- C. Approval of Shop Drawings or other submittals is not to be interpreted as approval of a substitute material. Approval of substitutions will be accomplished according to requirements set forth in Division 01 Section "Product Requirements."
- D. Action Submittals: The COR will review each submittal, make marks to indicate corrections or modifications required, and return the submittal to the Contractor. The COR will annotate each submittal with the action taken, as listed below. Do not permit submittals marked "Revise and Resubmit" or "Rejected" to be used at the Jobsite, or elsewhere where work is in progress.
 - 1. "Approved": Means fabrication/installation may be undertaken. Approval does not authorize changes to the Task Order Price, the Scheduled Substantial Completion Date, the Scheduled Final Completion Date, or interim milestones for the Task Order.
 - 2. "Approved as Noted": Same as "Approved," providing the Contractor complies with corrections noted on submittal. Resubmission required only if the Contractor is unable to comply with noted corrections.
 - 3. "Revise and Resubmit": Fabrication and/or installation may not be undertaken. Make appropriate revisions and resubmit, limiting corrections to items marked.
 - 4. "Rejected": Submittal does not comply with requirements. Fabrication and/or installation may not be undertaken. Prepare a new submittal according to requirements and submit without delay.
- E. Informational Submittals: The COR will annotate informational submittals with "No Action Taken", or "Rejected" if deviations from the Contract Documents are noted.
- F. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.
- G. Submittals not required by the Contract Documents will not be reviewed.

END OF SECTION 01 33 00

SECTION 01 40 00 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.
- B. Related Sections:
 - 1. Division 01 Section "Project Management and Coordination".
 - 2. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
 - 3. Division 01 Section "Submittals" for process required to submit the Contractor's Quality Control Plan.
 - 4. Division 01 Section "Execution".
 - 5. Division 01 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
 - 6. Division 01 Section "Project Closeout".
 - 7. Division 01 Section "Operation and Maintenance Data".
 - 8. Division 01 Section "Project Record Documentation".
 - 9. Division 01 Section "Demonstration and Training".
 - 10. Divisions 03 through 28 Technical Specification Sections

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Administrative and procedural requirements for the Contractor to provide and maintain an effective Quality-Control Program that complies with the Contract Documents.
 - 2. Establish a QC Program that consists of the following:
 - a. QC Organization.
 - b. QC Plan Meeting.
 - c. QC Plan.
 - d. Coordination and Meeting of Mutual Understanding.
 - e. QC meetings.
 - f. Phases of Control.
 - g. Submittal preparation, review, and approval.
 - h. Operation & Maintenance data and Warranty receipt verification prior to product delivery.
 - i. Material verification at delivery and material location reports as outlined in a formal Material Receiving Inspection Program.
 - j. Inspection Program utilizing an Inspection Log and Sign-off Sheets.
 - k. Testing and Inspections, completion inspections, QC certifications, accreditations, documentation, training, and requirements necessary to provide materials, equipment, workmanship, fabrication, construction, and operations that comply with the requirements of this Contract.

3. The Contractor is not responsible for Special Inspections according to requirements of the current IBC. The GPO's agent shall provide these Special Inspection services. However, the Contractor is responsible for establishing a Special Inspection schedule. This schedule shall be discussed at COR's weekly Progress Meetings and the Contractor's QC Meetings. The Contractor shall be responsible for all coordination and notification of requests for Code and Special Inspections with The GPO.
4. Special inspections are required for, but are not necessarily limited to, the following:
 - a. As identified by IBC 1704 Special Inspections Requirement.
5. Specific quality-control requirements for individual construction activities are specified in the Sections that require those activities. Requirements in those Sections may also cover production of standard products.
6. Schedule of Values: The Contractor shall include all test and inspection activities in its CPM and establish a Schedule of Values for all required QC documentation, all tests and inspection activities, reports, and procedures required in the Contract on a Section-by-Section basis. Additionally, the Contractor shall include a pay line item specifically for Quality activities and QC Organizational personnel required by the General Conditions. Quality activities shall be reported per Division 01 Section "Applications for Payment."
7. Specified tests, inspections, and related actions do not limit the Contractor's quality control procedures that facilitate compliance with the requirements of the Contract Documents.
8. The provisions of this Section shall not limit requirements for the Contractor to provide quality-control services required by the GPO or other agencies having jurisdiction. The QC Plan does not repeat or summarize the requirements of the Contract Documents. It describes the methods, processes, and procedures by which the Contractor will ensure Quality construction and compliance with the Contract Documents. Omissions in the QC Plan or the Contractor's Quality Control Program does not relieve the Contractor of the responsibilities to provide work in accordance with the Contract Documents, applicable codes, regulations, and governing authorities. Approval of the QC Plan by the GPO does not guarantee Quality Control or Quality Production by the Contractor. These QC processes, procedures and programs are controlled and managed by the Contractor.

1.3 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only:

1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
 - a. ASTM C 1077: Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation latest edition.
 - b. ASTM D 3666: Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials latest edition.
 - c. ASTM D 3740: Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction latest edition.
 - d. ASTM E 329: Agencies engaged in the Testing and/or Inspection of Materials Used in Construction latest edition.
 - e. ASTM E 543: Agencies performing Nondestructive Testing latest edition.
2. Government Publishing Office, 29 CFR 1926, most current edition.

1.4 DEFINITIONS

- A. Quality: Conformance to the requirements established by the contract specifications and drawings.
- B. Control: To guide and have influence over.
- C. Contractor Quality Control (CQC): The Contractor's system to establish, manage, control, and document their own, their Supplier's, and their Subcontractor's activities to ensure Quality compliance with the Contract Documents and the QC Plan.
- D. Contracting Officers Technical Representative (COR). Primary on-site representative of the Contracting Officer for technical matters. Duties and responsibilities of the COR will be transmitted to the Contractor via letter from the Contracting Officer.
- E. Definable Feature of Work or Element of Work: A definable feature of work (DFOW) or Element of Work is a task that is separate and distinct from other tasks and has control requirements and work crews unique to that task.
- F. QC Management System: The management and implementation of processes, procedures, and requirements that establish quality as identified in the QC Plan and mandated in the contract specifications. The Three Phases of Control are the core of the Contractor's Construction Quality Management System.
- G. Mockups: If required by the Construction Documents, shall be full-size, physical example assemblies that are constructed on site to illustrate finishes, materials, assemblies, etc. Mockups are used to verify selections made under Sample submittals, to demonstrate aesthetic effects or details and, where indicated, qualities of materials, execution, to review construction, coordination, testing, inspection, or operation; they are not Samples. Mockups establish the Initial Standard of Control by which the work shall be judged and accepted for that Definable Feature or Element of Work. Mockups supersede samples in the approval and acceptance of the Work. Construct mockups away from the work site or in a location designated by the COR. Do not use mockups as part of the work unless specifically approved by the COR.
- H. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of ten (10) projects similar in size and scope to this Task Order; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction. Specific experience requirements enumerated in these specifications supersede this requirement.

1.5 CONFLICTING REQUIREMENTS

- A. General: If compliance with two (2) or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the COR for a decision before proceeding. This paragraph refers to industry and government standards. In the event of a conflict between the drawings and CWP specifications, refer to Contract.

1.6 SUBMITTALS

- A. Submit the following in accordance with Division 01 Section, "Submittals."
 - 1. Action Submittals.
 - 2. Quality Control (QC) Plan.
- B. NOTE: Coordinate the submittal requirement dates with the submittal dates in Division 01 Section "Construction Progress Documentation".
- C. Submit a QC plan within twenty (20) calendar days after receipt of Notice to Proceed for the Task Order. The QC Plan shall include a preliminary submittal registry of all required submittals in the Task Order which shall be submitted in the first ninety (90) calendar days of construction. Insert the final submittal registry into the QC Plan once it is approved by the COR, to account for all submittals.
- D. Submit the résumés of key personnel to be assigned to the Task Order and the limits of their authority. Show how this Task Order management structure fits into the Contractor's overall management structure.
- E. Any approval by the COR of the QC Plan shall be treated as "accepted, dependent upon successful implementation of a Quality Program as outlined in the QC Plan and Contract Specifications." Omissions in the QC Plan do not relieve the Contractor of the responsibilities to comply with the Contract Documents. Immediately stop work if the QC Plan becomes disapproved or Quality as defined in the Contractor's Quality Program cannot be produced. The exception is the work authorized in the paragraph entitled "Preliminary Work Authorized Prior to Approval," shall be stopped by the Contractor.

1.7 INFORMATION FOR THE CONTRACTING OFFICER

- A. Provide samples of all report forms as identified below to the Contracting Officer during the Pre-Construction Conference for approval. The report forms shall consist of the Quality Control Daily Report, Superintendent Daily Report, Material Receiving Inspection Report, Preparatory Phase Report, Initial Phase Report, Inspection Log and Sign-off Sheet, Deficiency Log, Testing Log and Monthly Quality Control Summary Report. Other reports referenced below, once approved, may be in formats customarily used by the Contractor, and shall contain the information required by the contract specifications for Testing Laboratories and Inspection Reports, Material Location Reports, Specialist Reports, etc.
- B. Deliver the following listed items to the COR via the GPO directed Document Control at the times specified below:
 - 1. Quality Control Daily Report: one (1) electronic copy, delivered the next calendar day after work is performed.
 - 2. Superintendent's Daily Report: one (1) electronic copy, delivered the next calendar day after work is performed. Do not attach to the Quality Control Daily Report.
 - 3. Material Receiving Inspection Report: one (1) electronic copy, delivered the next calendar day after work is performed. Do not attach to the Quality Control Daily Report.
 - 4. Preparatory Phase Report: one (1) electronic copy, delivered the next calendar day after work is performed. Do not attach to the Quality Control Daily Report.
 - 5. Initial Phase Report: one (1) electronic copy, delivered by the next calendar day after work is performed. Do not attach to the Quality Control Daily Report.
 - 6. Field or Laboratory Test and Inspection Reports: one (1) original and one (1) electronic

copy, delivered within two (2) workdays after the inspection and/or test is performed. A certified technician performing all field tests and inspections shall sign all inspection and test reports. A certified testing laboratory manager performing all laboratory tests shall sign all test results. All reports will be reviewed, signed, and certified by a Professional Engineer, registered in the Commonwealth of Virginia, as complying with the contract specifications. Do not attach to the Quality Control Daily Report.

7. Inspection Log and Signoff Sheets for all Definable Features or Elements of Work: one (1) electronic copy, delivered within one (1) workday of the inspection or Signed-off activity. Do not attach to the Quality Control Daily Report.
8. Special Inspection Control Log: one (1) electronic copy, delivered within two (2) workdays of the end of the month.
9. Testing Log: upon COR's request, deliver one (1) electronic copy of a current up-to-date test log, documenting all performed tests, results, etc., do not attach to the Quality Control Daily Report.
10. Deficiency Log: one (1) electronic copy and one (1) hard copy delivered to the COR at the Progress Meeting. Do not attach to the Quality Control Daily Report.
11. QC Meeting Minutes: one (1) electronic copy delivered within two (2) workdays after the meeting. Do not attach to the Quality Control Daily Report.
12. QC Certifications, Qualifications, and Accreditations: as required by contract specifications.
13. Monthly Quality Control Summary Report: one (1) original copy and one (1) electronic copy, delivered within two (2) workdays of the end of the month. Do not attach to a Quality Control Daily Report. This Executive Brief shall contain these items:
 - a. Status of the CPM Schedule (Monthly Progress Report) impact to the schedule due to change notices, modifications, problems encountered, weather, and any other changes or items affecting the schedule since the previous month.
 - b. Status of Submittals.
 - c. Status of Testing and Inspections activities performed that particular month.
 - d. Status of Special Inspections performed that particular month.
 - e. Status of Preparatory meetings and Initial meetings performed that particular month.
 - f. Status of Deficiencies/Rework items and corrective actions.
 - g. Status of Non-compliances issued by the COR and the Contractor's corrective actions.
 - h. Status of Record Drawings.
 - i. Status or Identification of items affecting Quality.
 - j. Status of Training, Operation, Maintenance, and Warranty items.
 - k. Status of Safety and related events.
 - l. Other items as directed by the COR.
14. QC Specialist Reports: one (1) original and one (1) electronic copy, delivered the next calendar day after work is performed. Do not attach to the Quality Control Daily Report.

1.8 QC PROGRAM REQUIREMENTS

- A. The Contractor shall establish and maintain an approved QC Program as described in this Section. The QC Program shall consist of, but is not limited to, the following:
 1. QC Organization.
 2. QC Plan.
 3. QC Plan Meeting.
 4. Coordination and Meeting of Mutual Understanding.

5. QC meetings.
6. Phases of Control.
7. Submittal preparation, review, and approval.
8. Operations and Maintenance data.
9. Warranty receipt verification prior to product delivery.
10. Material verification at delivery and material location reports as outlined in a formal Material Receiving Inspection Program.
11. Inspection Program utilizing an Inspection Log and Sign-off Sheets.
12. Testing, inspections, completion inspections, QC certifications, accreditations, documentation, training, and requirements necessary to provide materials, equipment, workmanship, fabrication, construction, and operations that comply with the requirements of the Contract Documents.
13. The QC Program shall cover on-site and off-site work and shall be keyed to the work sequence.
14. No work, testing, or inspections may be performed unless the QCM or a pre-approved alternate is on the work site.
15. At all times during performance of this contract and until the work is completed and accepted, the Contractor shall directly superintend the work by an approved competent superintendent who is satisfactory to the Contracting Officer and has the authority to act for the Contractor.
16. The QCM shall report to an officer of the firm and shall not be subordinate to the Project Manager, Superintendent or any other member of the QC Organization.
17. The Quality Control Manager is the primary individual responsible for the management and implementation of processes, procedures, and requirements that establish quality in construction as identified in the QC Plan and mandated in the contract specifications. The QCM shall identify, track and report all weaknesses and deficiencies in this QC Management System. The Project Superintendent shall be responsible for the quality of all the production work.

B. Preliminary Work Authorized Prior to Approval:

1. The only work that is authorized to proceed prior to the approval of the QC Plan is mobilization of storage and office trailers, utility locating, installation of temporary utilities, and surveying.

C. Approval: Approval of the QC Plan is required prior to the start of any work or construction. The Contracting Officer reserves the right to require changes in the QC Plan, processes, procedures, and operations as necessary to ensure the specified quality of work is constructed as outlined in the Construction Documents. The Contracting Officer reserves the right to interview any member of the QC organization at any time during the contract period to verify contract compliance. All QC organizational personnel shall be subject to acceptance by the Contracting Officer. The Contracting Officer may require the removal of any individual for non-compliance with quality requirements specified in the contract.

D. Notification of Changes: Notify the COR, in writing, of any proposed changes to the QC Plan, including changes in the QC organizational personnel, a minimum of seven (7) calendar days prior to a proposed change. Proposed changes shall be subject to acceptance by the Contracting Officer.

1.9 QC ORGANIZATION

- A. The Contractor's QC Organization is responsible for establishing a committed unified team in a positive cooperative environment where all personnel and employees communicate, create, maintain, and verify the desired level of quality in all aspects of construction as established in the QC Plan and Specifications.
- B. Construction Quality Management Training: In addition to the cited experience and education requirements, the Program Manager, Program Quality Control Manager, Project Manager, Superintendent, Quality Control Manager, Quality Control Assistant, and Alternate Quality Control Manager shall have completed the course entitled "Construction Quality Management for Contractors." For each Construction Work Package, if these individuals do not have a current certification, they shall obtain the CQM course certification within 60 - calendar days of award of the Task Order. This short course is periodically offered in alternate months by: (1) the Maryland Chapter, Associated General Contractors (AGC), 410-321-7870; agcmd@aol.com and by (2) the Virginia Chapter, Associated Builders and Contractors (ABC), 703968-6205, joanna@abdva.org; mervin@abc.org. The training uses Army Corps of Engineers course content. The course is facilitated by instructors from Army Corps of Engineers, North Atlantic Division, Baltimore District, and by instructors from the Naval Facilities Engineering Command, Engineering Field Activity Chesapeake.
- C. Staffing Levels: Provide sufficient qualified quality-control personnel to monitor each work activity at all times. Scheduling and coordinating of all inspections and testing shall match the type and pace of work activity:
 - 1. In cases where multiple trades, disciplines, or Subcontractors are on site concurrently, each activity shall be tested and inspected by personnel skilled and qualified in that portion of the work.
 - 2. In cases where multiple shifts are employed, the quality-control staff shall be increased to meet all personnel and quality requirements of this section and the contract specifications for each shift when work is performed.
 - 3. In all cases, the QC Organizational staff shall not be assigned escorting duties.
- D. For the Task Order construction, the following positions are key personnel as defined by the GPO in this and other Division 01 Specification Sections. The QC Organizational personnel shall be interviewed by GPO's Quality Department and the COR. All QC Organizational personnel are subject to the COR's approval:
 - 1. Project Manager:
 - a. Duties: The Project Manager is the Contractor's full time on-site representative for the Construction Work Package with overall responsible for contract compliance, Quality in Construction, project management control, planning, scheduling, cost, project administration, submittal management, and compliance with local and national codes. The Project Manager shall report directly to the COR.
 - b. Qualifications: A minimum of fifteen (15) years of progressive construction supervisory experience, with at least five (5) years of experience as a Project Manager with direct, overall responsibility for managing contracts of similar size, type, and complexity to the Construction Work Package is required. A bachelor's degree in construction, engineering, architecture, or equivalent education and experience is required. Completion of the "Construction Quality Management for Contractors" course and current certification is required. Must be legally authorized to work in the United States, and must be eligible to obtain security clearances.

2. General Superintendent:

- a. Duties: The General Superintendent is the Contractor's full time on-site representative for the Construction Work Package that serves as the Jobsite production manager to plan, organize, coordinate, supervise, and observe all Jobsite construction activities. The General Superintendent shall report directly to the Project Manager. The General Superintendent controls all aspects of the Jobsite; enforces environmental, health and safety requirements; coordinates the Work in advance; monitors, controls and supervises all field personnel and activities; ensures compliance with the Construction Documents; controls, enforces and is responsible for the Quality of work produced; is responsible for timely performance of the Work; and documents the Jobsite activity each day. The General Superintendent corrects all noted deficiencies and ensures Quality is established and preserved in the construction process through the Three Phases of Control. The General Superintendent cooperates and coordinates the Work with the GPO, the Architect-Engineer, GPO tenants and concessionaires, and other contractors.
- b. Qualifications: A minimum of fifteen (15) years of progressive construction supervisory experience, with at least five (5) years of experience as a Superintendent with direct, overall responsibility for managing contracts of similar size, type, and complexity to the Construction Work Package is required. A bachelor's degree, an associate's degree, or Journeyman status in a building trade is required. Completion of the "Construction Quality Management for Contractors" course and current certification is required. OSHA 30 hour safety training, first aid and CPR certifications are required. Must be legally authorized to work in the United States, and must be eligible to obtain security clearances.

3. Quality Control Manager (QCM)

- a. Duties: The Quality Control Manager (QCM) is the Contractor's full time on-site representative for the Construction Work Package that is responsible for implementation, management and enforcement of the Contractor's Quality Control (QC) Program. The QCM shall report to the Program Quality Control Manager and the Project Manager. The only duties and responsibilities of the QCM are to implement, manage and enforce the QC Program on the Construction Work Package. The QCM shall not be designated as the safety competent person as defined by Construction Safety manual. The QCM shall attend the QC Plan Meeting, shall prepare the QC Plan for COR approval, shall conduct the Meeting of Mutual Understanding, conduct the QC meetings, perform and manage the Phases of Control, except for those phases of control designated to be performed by QC Assistant and/or QC specialists, perform submittal review and approval, ensure verification of materials, ensure all testing and inspections are coordinated and performed by trained, authorized and certified personnel and testing laboratories. The QCM shall provide and submit QC certifications, accreditations, reports, and documentation as required in the Contract Documents. The QCM shall not prepare Submittals. The QCM is responsible for assuring compliance with Quality Standards as established in the Construction Documents.
- b. Qualifications: A licensed Professional Engineer (PE) in the District of Columbia with a minimum of ten (10) years' experience as a superintendent, QCM, project manager or construction manager on construction contracts similar in size and type to the Construction Work Package, including the major trades that are involved, is required. Completion of the "Construction Quality Management for Contractors" course and current certification is required. The individual shall be familiar with the requirements of the GPO Construction Safety Manual, and have experience in the areas of hazard

identification and safety compliance. Must be legally authorized to work in the United States, and must be eligible to obtain security clearances.

4. Alternate QCM Duties and Qualifications:

- a. Duties: Designate an alternate for the QCM at the Jobsite to serve in the event of the designated QCM's absence. The period of absence may not exceed two weeks at one time, and not more than thirty (30) workdays during a calendar year.
- b. Qualifications: The qualification requirements for the Alternate QCM shall be the same as for the QCM.

5. QC Assistant

- a. Duties: Provide a QC Assistant to the QCM at the work site to assist with:
 - 1) Performance of the Phases of Control; verification of materials; providing and submitting QC certifications, accreditations, reports, and documentation as required by the Construction Documents; and to ensure all testing and inspections are coordinated and performed by trained, authorized, and certified personnel and testing laboratories. The Assistant QCM shall be on the work site during supplemental work shifts and may be authorized to perform the duties of the QCM during such supplemental shift work.
 - 2) Qualifications: The qualification requirements for the Assistant QCM shall be a graduate of a four year ABET accredited college program in one of the following disciplines: Engineering, Architecture, Construction Management, Engineering Technology, Building Construction, Building Science, with a minimum of 5 of years of experience. The individual shall be familiar with the requirements of the GPO's Construction Safety Manual, and have experience in the areas of hazard identification and safety compliance.

6. QC Administrative Assistant Duties: The QC Administrative Assistant's primary duties at the work site shall be to help the QCM in processing and maintaining files for submittals and preparing and publishing reports and meeting minutes. After primary duties are accomplished, other duties may be assigned provided the duties do not interfere with primary duties.

- a. Qualifications: Basic understanding of construction activities, maintaining construction files, and knowledge of construction procedures and practices related to construction and the contract specifications; Basic understanding of the Construction Specifications Institute's (CSI) Master Format organization for Specification Divisions.

7. Submittal Reviewers: Duties: Submittal Reviewers shall be qualified in the discipline(s) being reviewed. Reviewers shall review and certify that each and all submittals meet the requirements of the Construction Documents prior to review and approval by the

8. QCM:

- a. Qualifications: Each submittal shall be reviewed and certified by a registered Professional Engineer in the Commonwealth of Virginia with ten (10) years construction experience.

9. QC Specialists Duties and Qualifications:

- a. Duties: Provide a separate QC specialist at the work site for each specialized portion of the work, who shall assist and report to the QCM and who shall have no duties other than the assigned quality control duties. QC specialists are required to attend the Meeting of Mutual Understanding, QC meetings, and be physically present at the construction site to perform the Phases of Control and prepare documentation for each definable feature or element of work in their area of responsibility at the frequency specified below.

Qualification/Experience in Area of Responsibility	Area of Responsibility	Frequency
To be identified for each Task Order		

10. Registered Fire Protection Engineer (FPE):

- a. Duties: Shall be an independent third party hired directly by the Contractor as an integral part of the prime construction Contractor's Quality Control Organization. The Registered FPE shall have no business relationships with the Contractor (owner, partner, operating officer, distributor, salesman, or technical representative) or with any Subcontractors involved with this project; or with any fire protection equipment device manufacturers, Suppliers, or installers for any such equipment provided as part of this project. The Registered FPE shall be responsible for review, approval, and coordination of all fire protection system material submittals, calculations, shop drawings, etc.
- b. Qualifications: The Fire Protection Engineer shall be a registered Professional Engineer in the Commonwealth of Virginia who has had a minimum of ten (10) years' experience as a fire protection engineer.

1.10 QC PLAN MEETING

- A. At the direction of the COR, after notice of proceed for each Task Order and prior to submission of the QC plan, meet with the COR and QA Manager to discuss the QC plan requirements. The purpose of this meeting is to communicate expectations and facilitate understanding of the QC plan requirements prior to plan development and submission.

1.11 QUALITY CONTROL (QC) PLAN

- A. The QC Manager shall prepare and provide, for approval by the COR, a QC plan submitted in a 3-ring binder with pages numbered sequentially that covers both on-site and off-site work and includes but may not necessarily be limited to the following:
- B. A table of contents listing the major sections identified with tabs in the following order:
1. QC ORGANIZATION
 2. PERSONNEL MATRIX
 3. NAMES AND QUALIFICATIONS
 4. DUTIES, RESPONSIBILITY AND AUTHORITY OF QC PERSONNEL

5. APPOINTMENT LETTERS
 6. OUTSIDE ORGANIZATIONS QC STAFF (Subcontractors and consultants)
 7. INSPECTION AND TESTING AGENCIES CERTIFICATIONS, QUALIFICATIONS, AND ACCREDITATIONS
 8. TESTING AND INSPECTION PLAN, AND TESTING LOG
 9. SUBMITTAL PROCEDURES, 90 DAY INITIAL SUBMITTAL REGISTER, AND FINAL SUBMITTAL REGISTER WHEN APPROVED BY COR
 10. LIST OF ALL DEFINABLE FEATURES OR ELEMENTS OF WORK
 11. PROCEDURES FOR PERFORMING THE PHASES OF CONTROL
 12. SPECIAL INSPECTION REQUIREMENTS, DUTIES, AND RESPONSIBILITIES OF SPECIAL INSPECTORS, SPECIALISTS, SPECIALTY PERSONNEL, AND MANUFACTURERS REPRESENTATIVES
 13. DOCUMENTATION REQUIREMENTS AND PROCEDURES
 14. PROCEDURE TO IDENTIFY, RECORD, TRACK, COMPLETE AND ELIMINATE DEFICIENCIES AND REWORK ITEMS
 15. PROCEDURES FOR COMPLETION INSPECTION
 16. FORMS
 17. ATTACHMENTS
- C. A chart showing the QC organizational structure.
- D. A personnel matrix showing for each Section of the specifications who, by name, shall review and approve submittals, who, by name, shall perform and document the Phases of Control, and who, by name, shall perform and document the testing and inspections.
- E. Names and qualifications, in résumé format, for each person in the QC organization. Include the QCM course certifications for the Project Manager, Superintendent, QCM, QC Assistant and Alternate QCM as required by the paragraphs entitled “Construction Quality Management Training” and “Alternate QCM Duties and Qualifications”.
- F. Identify duties, responsibilities, and authority of each person in the QC organization.
- G. Letters signed by an officer of the firm appointing the QCM and Alternate QCM, stating that they are responsible for implementing and managing the Contractor’s QC Program and is the primary individual responsible for the management and implementation of processes, procedures, and requirements that establish quality in construction identified in the QC Plan as mandated in the Construction Documents. The QCM shall notify the GPO and Management of all failures and deficiencies in these QC management systems. Include in this letter the responsibility of the QCM and Alternate QCM to implement and manage the three phases of quality control and their authority to stop work that is not in compliance with the Contract Documents. The QCM shall issue letters of direction to all other QC staff and specialists under their control outlining their duties, authorities, and responsibilities, as outlined in the QC Organization section of the contract specifications. Copies of the letters shall be included in the QC plan.
- H. A listing of all Subcontractors employed by the Contractor, a description of each Subcontractor’s provided services, each Subcontractor’s QC representative’s name, and contact phone numbers.
- I. Testing laboratory information required by the paragraphs entitled “Accreditation Requirements” or “Construction Materials Testing Laboratory Requirements”, as applicable. Include all certification and accreditation requirements required in the contract for each laboratory and testing technician.

- J. Submit in this section all certifications, qualifications, and accreditations as required for each Section, Definable Feature or Element of Work in the Specifications.
- K. A Testing and Inspection Plan, and Testing Log that includes all tests and inspections required in the contract, referenced by the specification paragraph number requiring the test and inspection, the frequency, the desired results, and the person, by name, responsible for each test and inspection, and shall be identified as a scheduled (CPM) activity.
- L. Procedures for preparing, reviewing, approving, and managing submittals. Provide the name(s) of the person(s) in the QC organization authorized to prepare, review and certify submittals prior to approval. The QCM shall not prepare submittals. Provide the initial submittal register as specified in Section entitled "Submittals." Once the final submittal registry, accounting for all submittals, is approved by the COR, insert the registry into the QC Plan.
- M. List of Definable Features or Elements of Work. The list shall be cross-referenced to the Contractor's CPM Schedule and all specification sections. For Task Orders requiring a Network Analysis Schedule, the list of definable features or elements of work shall include but not be limited to all critical path activities. Include a chart of common deficiencies for all definable features or elements of work. Detail the control procedures that shall be employed to eliminate these common deficiencies. All elements of work and definable features of work in this contract shall be incorporated in the Three Phases of Control.
- N. Procedures for Performing the Three Phases of Control. The primary purpose of the Three Phases of Control is to require the Contractor to plan and schedule each work activity to ensure quality is established, constructed, and maintained for each Definable Feature or Element of Work as required in the contract specifications. The Contractor shall develop a plan for incorporating each of the Definable Features or Elements of Work into a Quality Production effort. The Three Phases of Control are the core of the Contractor's Construction Quality Management System as outlined in the Contractor's QC Plan and contract specifications. The plan shall detail who shall be responsible for scheduling the phases, conducting the phases, as well as documenting the phases of work. The use of project specific checklists forms may be helpful. However, the QC Plan and the contract specifications requirements establish the quality, not just the checklists. The Preparatory and Initial Phases and meetings shall be conducted with a view towards establishing, achieving, and maintaining quality construction by planning ahead and identifying potential problems early for each Definable Feature or Element of work.
- O. Establish an Inspection Program utilizing an Inspection Log and Signoff Sheets: The Contractor's superintendent shall establish, coordinate, and maintain with all trades and personnel, for each Definable Feature or Element of Work, a system of inspections and signoff sheets to certify that all work under the superintendent's control has been coordinated, constructed, and installed according to the plans and specifications. All work shall be documented as being inspected and signed-off by the Contractor before starting and performing construction on the next Definable Feature or Element of Work. These inspections and sign-off sheets shall be incorporated into the Phases of Control.
- P. Identify all inspection requirements, duties, and responsibilities of Specialists, Specialty Personnel, and Manufacturer's Representatives. As outlined by the Engineer of Record, include a separate list of Special Inspections according to the requirements of the current IBC.
- Q. Documentation procedures and requirements, including proposed report formats, necessary to provide materials, equipment, workmanship, fabrication, construction and operations that comply with the requirements of this Contract.

- R. Procedures to identify, record, track, complete, and eliminate deficiencies and rework items.
- S. Procedures for Identifying and Documenting the Completion Inspection process. Include in these procedures the responsible party for punch out inspection, pre-final inspection, and final acceptance inspection.
- T. Submit, for approval, a complete set of report forms to be utilized on this project.
- U. All applicable Subcontractors and Suppliers Quality Control Plans complete with the Contractor's CQC planned involvement.

1.12 MEETING OF MUTUAL UNDERSTANDING

- A. After submission and approval of the QC Plan, and prior to the start of any physical construction, meet with the COR and Subcontractors to present the Contractor's QC Program. The purpose of the meeting is to develop a mutual understanding of the Contractor's Quality Control Program, to include the Contractor's QC details, processes, and procedures to assure and control quality, including the requirements of documentation, administration for on-site and off-site work, and the coordination of the Contractor's management, production, and QC personnel. At the meeting, the Project Manager and QC Manager shall be required to explain in detail how the QC Program works. Discuss the Phases of Control and how it will be implemented for each definable feature or element of work. As a minimum, the Contractor's personnel required to attend shall include the Project Manager, and the Project Manager, Project Superintendent, QCM, Alternate QCM, QC Assistant, QC Specialist(s) and Subcontractor Representatives for each Definable Feature or Element of Work involved in the Task Order. Include all Testing and Inspection Agencies required for the Task Order. Each Subcontractor assigned to the Task Order shall have QC duties and responsibilities and shall have a principal of the firm at the meeting. Minutes of the meeting shall be prepared by the QCM and signed by the Contractor's Program and Project Managers. The Contractor shall provide a copy of the signed minutes to all attendees.

1.13 QC MEETINGS

- A. After the start of construction, the QCM shall conduct QC meetings weekly at the Jobsite with the Project Manager, Superintendent, QC Assistant, QC Specialist(s), Subcontractor's Foremen and Safety Representative. The QCM shall prepare the minutes of the meeting and provide a copy to the COR within two (2) workdays after the meeting. The COR may attend these meetings.
- B. The QCM shall notify the COR at least two (2) workdays in advance of each meeting. To prepare, review, and address quality issues as outlined below and as addressed in the COR's Progress Meeting, the QCM shall conduct these meetings in advance of the COR's weekly progress meeting. As a minimum, the following shall be discussed and addressed at each QC meeting:
 - 1. Review the minutes of the previous meeting.
 - 2. Review the schedule and the status of work:
 - a. Work, testing, or inspections accomplished since last meeting
 - b. Special Inspections scheduled in the next two (2) weeks
 - c. Inspection and Signoff schedules in the next two (2) weeks for each Definable Feature of Work

- d. Rework items and deficiencies identified since last meeting
 - e. Rework items and deficiencies corrected since last meeting
- 3. Review the status of submittals, O & M data and Warranty Manuals:
 - a. Submittals, O & M data and Warranties reviewed and approved since last meeting
 - b. Submittals, O & M data and Warranties required in the near future
- 4. Review the work to be accomplished in the next three (3) weeks:
 - a. Establish completion dates for rework items and deficiencies.
 - b. Update the schedule showing planned and actual dates of the preparatory, initial, and follow-up phases, including testing and any other inspections required by this contract.
 - c. Discuss construction methods and the approach that shall be used to provide quality construction by planning ahead and identifying potential problems for each definable feature or element of work.
 - d. Discuss status of off-site and on-site work for inspections and testing.
 - e. Documentation required for each construction activity and definable feature or element of work.
 - f. Discuss upcoming Job Hazard Analyses (JHAs).
- 5. Resolve QC and production problems and assist in resolving Request for Information issues.
- 6. Address items that may require revising the QC plan:
 - a. Changes in QC organization personnel.
 - b. Changes in processes, procedures, checklists, qualifications, accreditations, certifications, testing, inspections, etc....
- 7. Review health and safety plan.

1.14 PHASES OF CONTROL

- A. The Phases of Control shall adequately cover both on-site and off-site work and shall include the following for each definable feature or element of work. Managed by the Contractor, with COR approval, the Three Phases of Control are the core of the Construction Quality Management System.
- B. Preparatory Phase: Notify the COR at least two (2) workdays in advance of each preparatory phase. This phase shall include a meeting conducted by the QC Manager and attended by the Superintendent, QC Assistant, QC Specialist(s), all Subcontractors' foremen responsible for the definable feature or element of work, the Contractor's Independent 3rd Party Testing, and Inspection Agencies, and the Contractor's Safety Representative. Preparatory meetings will not be conducted without having these individuals, approved submittals and approved JHAs present at the meeting. If all personnel are not present, or if submittals and JHAs are not approved, cancel the Preparatory Phase meeting. Document the results of the preparatory phase actions in the daily Quality Control Daily Report and in the Preparatory Phase Checklist. As a minimum the following should be covered prior to beginning work on each definable feature or element of work:

1. Review each paragraph of the applicable specification sections.
 2. Review the project drawings.
 3. Verify that appropriate shop drawings, O & M data, Warranties, and submittals for materials and equipment have been submitted and approved. Verify receipt of approved factory test results, when required. If submittals are not approved, cancel the Preparatory Phase meeting.
 4. Establish control to be utilized to assure work complies with the contract plans and specifications.
 5. Review the testing and inspection plan and ensure that provisions have been made to provide the required QC testing and inspections.
 6. Examine the work area to ensure that the required preliminary work has been completed.
 7. Examine the required materials, equipment, and sample work to ensure that they are on hand and conform to the approved shop drawings and submitted data.
 8. Discuss construction methods, construction tolerances, workmanship standards, and the approach that shall be used to provide quality construction by planning ahead and identifying potential problems for each definable feature or element of work.
 9. Discuss control measures to ensure quality through a system of sign-off sheets and inspections. All work shall be inspected and signed-off by the Contractor before starting construction on the next Definable Feature or Element of Work. These inspections shall be incorporated into the Phases of Control.
 10. Review the safety plan and appropriate job hazard analysis (JHA) to ensure that applicable safety requirements are met, and that required Material Safety Data Sheets (MSDS) are submitted. If the JHA is not approved, cancel the Preparatory Phase meeting.
- C. Initial Phase: Notify the COR at least two (2) workdays in advance of each initial phase. When the Standard of Quality for workmanship has been established for that definable feature or element of work, conduct the Initial Phase with the QC Manager, Superintendent, QC Assistant, QC Specialist(s), all Subcontractors' foremen responsible for the definable feature or element of work's quality standard, the Contractor's Independent 3rd Party Testing and Inspection Agencies, and the Contractor's Safety Representative. Initial meetings will not be conducted without having these individuals present at the meeting, having approved submittals, and approved JHAs.
- D. If all personnel are not present, cancel the Initial Phase meeting. Observe the initial segment of the definable feature or element of work to ensure that the work complies with Contract Documents. Document the results of the initial phase in the daily Quality Control Daily Report and in the Initial Phase Checklist. Repeat the initial phase for each new crew to work on-site, or when acceptable levels of specified quality are not being met. As a minimum the following should be covered for each definable feature or element of work:
1. Ensure controls established during Preparatory Phase are adequate to allow work to proceed in compliance with the plans and specifications.
 2. Establish the Standard of Control for Quality required for workmanship as required in the specifications.
 3. Resolve conflicts.
 4. Ensure testing and inspections are performed by an approved Independent 3rd Party Testing and Inspection Agencies.
 5. Discuss control measures to ensure quality through a system of sign-off sheets and inspections. All work will be inspected and signed-off by the Contractor before starting construction on the next Definable Feature or Element of Work. These inspections shall be incorporated into the Phases of Control.
 6. Check work procedures for compliance with the Safety Plan and the appropriate job hazard analysis to ensure that applicable safety requirements are met.

- E. Follow-Up Phase: Perform the following for on-going daily work, or more frequently as necessary until the completion of each definable feature or element of work and document in the daily Quality Control Daily Report:
1. Ensure the work is in compliance with the Contract Documents.
 2. Maintain the Standard of Control for Quality of workmanship established at the Preparatory and Initial Phases.
 3. Ensure that testing and inspections are performed by an approved Independent 3rd Party Testing Agency.
 4. Ensure that rework items and deficiencies are being identified, tracked, and corrected.
 5. All work will be inspected and signed-off by the Contractor before starting construction on the next Definable Feature or Element of Work.
 6. Eliminate repetitive Deficiencies and Rework.
 7. Perform safety inspections.
- F. Code-Required Inspections:
1. Comply with the current edition, approved by the District of Columbia of the USBC, "Special Inspections" or other agencies having jurisdiction.
 2. The Contractor is not responsible for Special Inspections according to requirements of the current Uniform Statewide Building Code (USBC). Special Inspections are to be performed by the GPO's agent.
 3. The Contractor will maintain and submit monthly a Code and Special Inspection Control Log, chronologically recording each Code and Special Inspection notification to the COR, testing and/or inspections performed under the USBC, or other agencies having jurisdiction on-site, including the nature of the tests or inspections, the date performed, the results, approval or causes for rejection, corrective action taken, and dates of subsequent tests, inspections and final acceptance.
 4. Notice to COR: Notify COR, in writing, at least two (2) workdays in advance of all code-required inspections. COR should be apprised in advance of every preparatory and initial inspection. All preparatory, initial, and follow-up inspections shall be made a matter of record in the Contractor's quality-control documentation.
- G. Additional Preparatory and Initial Phases:
1. Additional Preparatory and Initial Phase meetings shall be repeated for all definable features or elements of work where the Initial Standard of Control has changed or is not maintained; examples where Preparatory or Initial Meetings may need to be repeated are:
 - a. Changes in the QC Organization, supervision, or changes to personnel performing the work.
 - b. When the quality standards established at the Preparatory and Initial Meetings have changed or are no longer acceptable.
 - c. Changes of materials.
 - d. Changes in equipment.
 - e. Changes in the Season.
 - f. Changes in Weather.
 - g. Changes to the Environment.
 - h. If work is resumed after a substantial period of inactivity.
 - i. When the standard of Quality is not recognized or understood by those producing the work as established in the specifications and the Three Phases of Control meetings.
 - j. As required by the COR in writing.

- H. Notification of Phases of Control for Off-Site Work: On determination by COR that an item shall require surveillance by the GPO at the point of production, manufacture, or shipment, the Contractor shall be notified, in writing, of such determination. The Contractor shall furnish to COR three copies of all purchase orders or subcontracts, for all tiers of Subcontractors or Suppliers for each item. In addition, copies of documented quality-control operations, tests, and inspections shall be made available to the GPO's representative at the point of production, manufacture, or shipment. The QCM shall notify the COR at least three (3) weeks prior to the start of the preparatory and initial phases.
- I. Notification of Off-Site Inspections and Tests: If Factory Witness Tests and Inspections are required for this project, follow procedures outlined in the technical specifications for scheduling, testing, and inspection requirements. Identify these tests and inspections in the Contractor's QC Plan.

1.15 SUBMITTAL REVIEW AND APPROVAL

- A. Procedures for preparation, review, approval, and submission of submittals are described in Division 01 Section "Submittals".
- B. The QC Manager shall not prepare submittals, but shall review and approve submittals.

1.16 TESTING

- A. Comply with all testing and inspection requirements as outlined in the technical specification sections of this contract, to include compliance with all applicable provisions and requirements of Division 1.
- B. Independent Testing and Inspection Laboratory: When codes or requirements of the contract require tests or inspections by civil, mechanical, electrical, USBC, or other entities, a corporately and financially independent testing or inspection organization shall be contracted by the Contractor to perform these contractually required tests and inspections. These testing and inspection agencies shall function as an unbiased testing and inspection authority; professionally independent of the Contractor, Subcontractors, manufacturers, Suppliers, and installers of equipment; or systems evaluated by the testing and inspection organizations for this contract. The various types of independent accrediting agencies and requirements are listed below:
- C. Accreditation Requirements: Construction materials testing and inspection laboratories performing work on GPO construction contracts shall be accredited by one of the laboratory accreditation authorities. The laboratory's scope of accreditation shall include the ASTM standards listed in the paragraph titled "Construction Materials Testing Laboratory Requirements" as appropriate to the testing field. The policy applies to the specific laboratory performing the actual testing or inspection and the testing technicians performing the tests and inspections, not just the "Corporate Office".
- D. Electrical testing of components, equipment, and systems: The testing firm shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems. The testing firm shall have at least five (5) years' experience in the testing of electrical equipment of the type, rating, and voltage used on this Project. The testing laboratories shall be a current full-member company of the International Electrical Testing Association (<http://www.netaworld.org/>). This independent testing firm shall perform testing and inspections as required under the terms of this

Contract.

- E. Structural and Pipe Welding: An independent testing and inspection firm shall perform all structural and pipe welding examinations as required by this Contract. The inspectors employed by the firm shall hold current certification as an AWS Certified Welding Inspector (CWI) for visual weld examinations and ASNT-TC-1A Certification for nondestructive examination of welds. ASNT-TC-1A certifications shall be by an ASNT-TC-1A ACCP Level III.
- F. Construction Materials Testing Laboratory Requirements: Provide an independent construction material testing laboratory accredited by an acceptable laboratory accreditation authority to perform sampling, inspections, and tests required by this Contract. Testing laboratories that have obtained accreditation by an acceptable laboratory accreditation authority listed in the paragraph entitled "Laboratory Accreditation Authorities" shall submit with the Quality Control Plan, a copy of the Certificate of Accreditation and Scope of Accreditation. The scope of the laboratory's accreditation shall include the test or inspection methods and certifications required by the Contract. On and Off-site testing and inspection facilities shall submit a certified statement by the Supervising Professional Engineer, licensed in the Commonwealth of Virginia, as meeting the specification requirements and the following minimum ASTM standards listed below as appropriate to field and laboratory testing and inspection. Include all Testing Technician qualifications per accredited Laboratory and specification requirements:
 - 1. Laboratories engaged in testing of construction materials shall meet the requirements of ASTM E 329.
 - 2. Laboratories engaged in testing of concrete and concrete aggregates shall meet the requirements of ASTM C 1077.
 - 3. Laboratories engaged in testing of bituminous paving materials shall meet the requirements of ASTM D 3666.
 - 4. Laboratories engaged in testing of soil and rock, as used in engineering design and construction, shall meet the requirements of ASTM D 3740.
 - 5. Laboratories engaged in nondestructive testing (NDT) shall meet the requirements of ASTM E 543.
 - 6. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA.
- G. Laboratory Accreditation Authorities: Laboratory Accreditation Authorities are the National Voluntary Laboratory Accreditation Program (NVLAP) administered by the National Institute of Standards and Technology, the American Association of State Highway and Transportation Officials (AASHTO) program, ICBO Evaluation Service, Inc. (ICBO ES), and the American Association for Laboratory Accreditation (A2LA) program and the Washington Area Council of Engineering Laboratories (WACEL). Furnish to the COR, a copy of the current Certificate of Accreditation and Scope of Accreditation. The scope of the laboratory's accreditation shall include the test and inspection methods required by the Contract.
- H. Capability Check: The COR retains the right to examine the laboratory equipment in the proposed laboratory, the laboratory's managers and testing technicians' qualifications, procedures, techniques, and other items for compliance with the standards set forth in this Contract.
- I. Capability Recheck: If non-conformities are discovered during the capability check or any succeeding recheck, The Contractor shall be assessed a charge of \$750.00 to reimburse the GPO for each recheck of the laboratory or the checking of a subsequently selected laboratory. These charges shall be deducted from the total amount due the Contractor.

- J. Test and Inspection Report Results: Cite applicable Contract Documents, tests, inspections, or analytical procedures used. Provide actual results and include a statement that the item tested, inspected, or analyzed conforms or fails to conform to specified requirements. IF THE ITEM FAILS TO CONFORM, NOTIFY COR IMMEDIATELY. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable. A certified testing laboratory manager performing all laboratory tests shall sign all test results. A certified technician performing all field tests and inspections shall sign all inspection reports. All test and inspection reports shall be reviewed, certified, and signed by a professional engineer, licensed in the Commonwealth of Virginia, as complying with the contract specifications, before submission to COR. Submit within two (2) workdays after the tests or inspections are performed.
- K. Control Tests: Outlines those tests and inspections conducted by the Contractor that assist in maintaining the standard of quality for all operations and procedures, for each Definable Feature or Element of Work, as identified in the Quality Control Plan and the Specifications. As described above, the Contractor shall procure the services of an independent commercial laboratory to perform the required control tests and inspections. The Contractor shall identify these minimum Control Test and Inspection requirements:
1. Procedures, requirements, analytical procedures used, and criteria for all Testing and Inspections.
 2. Methods of construction.
 3. Number of control tests, inspections, and frequency of tests and inspections to be made for each Definable Feature or Element of Work.
 4. Provide actual results and include a statement that the item tested, inspected, or analyzed conforms or fails to conform to specified requirements.
 5. Identify testing or inspection agency performing testing and inspections.
 6. Ensure proper certification and sign-off of all tests and inspections conducted and reviewed by the Contractor Independent testing and inspecting Technicians, Managers, and Professional Engineers.
 7. The QC Manager will ensure only accredited laboratories and certified technicians are performing testing and inspections as outlined in the contract specifications.
 8. Notify COR a minimum of two (2) workdays in advance of the Contractor performing any testing and inspections.
- L. Acceptance or Validation Testing by the GPO: The Contractor shall furnish to COR the quantities of materials to be used for Acceptance or Validation testing as required in the Specifications. Acceptance or Validation testing shall be performed by the GPO at an independent laboratory at no cost to the Contractor. No direct payment shall be made to the Contractor for the furnishing of materials used for Acceptance or Validation testing. The Authorities Acceptance and Validation program does not relieve the Contractor of its responsibility to fully comply with all regulations, standards, codes, and quality requirements of the contract specifications.
- M. Staffing: All laboratory, inspection, and testing technician personnel shall work in an accredited laboratory under the supervision of a Professional Engineer licensed in the District of Columbia.

1.17 QC CERTIFICATIONS

A. Quality Control Daily Report Certification

1. Each Quality Control Daily Report shall contain the following statement:

"On behalf of (*Name of the Contractor and Task Order number*), I certify that this report and the Inspector's Daily Reports are complete and correct, and that all materials and equipment used, as well as work performed during this reporting period are in compliance with Drawings, Specifications, and other Contract Documents, except as noted in this report or attached reports." B. Application for Payment Certification:

2. Refer to Division 01 Section "Application for Payment" for requirements and the address to which the Applications shall be sent.

- B. Completion Certification: Upon completion of work under this Contract, the QCM shall furnish a certification letter to the Contracting Officer attesting that "that all work required of the contract has been completed, inspected, tested and is in full compliance with the Contract Documents."

1.18 COMPLETION INSPECTIONS

- A. Punch-list Inspection: Near the completion of all work for a Construction Work Package or any increment thereof the QCM shall conduct an inspection of the Work and develop a "punch-list" of items which do not conform to the approved drawings and specifications. Include in the punch-list any remaining items on the "Deficiency Log" which were not corrected prior to the Punch-list Inspection. Submit an electronic copy of the proposed Punch List format for approval. The punch-list shall include for each item: an identification number; a description; the value; the location; the responsible Subcontractor; the status; schedule dates for the correction work; the completion date; an approval column for the QCM's initials and date; and an acceptance column for the COR's or designated representative's initials and date. Submit an electronic copy of the Punch List and updates of the Punch List using the Program Management Software system. Inspect areas outside of the limits of construction that were affected by the construction operations and list the items needing correction:

1. Organize the list of spaces in sequential order, starting with exterior areas first and proceeding from lowest to highest floor.
2. Organize the items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
 - a. Contract name and number
 - b. Task Order Name and Number
 - c. Date
 - d. Name of the Contractor
 - e. Name of the Architect/Engineer
 - f. Name of the COR
 - g. Page Number

- B. Pre-Final Inspection: The procedure for the Pre-Final Inspection is located in Section 017700 Project Closeout. The QCM and staff shall make follow-on inspections to ascertain that all deficiencies and Punch List items have been corrected before requesting a Pre-Final Inspection.

- C. Final Completion and Acceptance Inspection: The procedure for the Final Completion and Acceptance Inspection is located in Section 017700 Project Closeout.

1.19 DOCUMENTATION

- A. The Contractor shall maintain current quality control records, on approved forms, of all control activities, production, tests, and inspections performed. These records shall include factual evidence that required tests and/or inspections have been performed, including type and number of tests and/or inspections involved; results of tests and/or inspections; nature of defects, causes for rejection, etc.; proposed remedial action; and corrective actions taken. These records shall cover both conforming and defective or deficient features (non-conforming work) and shall include a statement that all supplies and materials incorporated into the work are in full compliance with terms of the Contract Documents as documented in the Contractor's materials receiving inspection program. Only Legible copies of these records shall be furnished, submitted, and delivered to COR. The records shall cover all work placed subsequent to the previously furnished records and shall be verified by the Contractor's QCM. The Contractor shall document all tests and inspections as specified in the technical provisions of the Specifications. All specified records shall be readily available for review by COR throughout the life of the Contract.
- B. Maintain current and complete records of on-site and off-site QC Program operations and activities. Establish and maintain the following in a series of 3 ring binders. Binders shall be divided and tabbed as shown below. These binders shall be readily available to the GPO's Quality Assurance Team upon request.
1. All completed Preparatory and Initial Phase Reports, arranged by specification Section, Definable Feature, or Element of Work.
 2. All milestone and required inspections, arranged by Activity/Event Number.
 3. Special Inspection Control Log, arranged by Definable Feature or Element of Work and Trade.
 4. A current up-to-date copy of the approved Testing and Inspection Plan, and supporting documentation that accounts for all testing and inspection requirements as listed in the specifications and the Monthly Summary Report of Tests and Inspections that documents all field tests, inspections, reports, and supporting documentation, arranged by date for each Definable Feature or Element of Work as identified in each specification section.
 5. A current up-to-date copy of the Superintendent's inspection logs and sign-off sheets for each Definable Feature or Element of Work.
 6. Copies of all contract RFIs, arranged in numerical order.
 7. Copies of all contract modifications, arranged in numerical order. Also include documentation that modified work was accomplished.
 8. A current up-to-date comprehensive copy of the Deficiency Log and Noncompliance Log.
- C. Report Forms - A copy of all approved forms shall be included with the Quality Control Plan. The forms shall be designed to assist in the control of the quality. The following minimum requirements are listed for specific reports:
1. Quality Control Daily Report: Reports are required for each day that work is performed and for every seven consecutive calendar days of no work and on the last day of a no work period. Account for each calendar day throughout the life of the Contract. The reporting of work shall be identified by terminology consistent with the construction schedule. Quality Control Daily Reports are to be prepared, signed and dated by an approved QCM and shall contain the following information:
 - a. Identify Date of report, report number, Contract Number and Title, and Task Order Number and Title.
 - b. Identify CPM Schedule Activity No., Submittal # and list equipment/material received each day that is incorporated into the job.
 - c. Indicate if Preparatory Phase work was performed today (Yes/No checkboxes).

- d. If Preparatory Phase work was performed today (including on-site and off-site work), identify its CPM Schedule Activity Number and Definable Feature or Element of Work. The Index number is a cross reference to the Preparatory Phase Checklist. An example of the Index number is: 0025-P01, where "0025" is the Quality Control Daily Report Number, "P" indicates Preparatory Phase, and "01" is the Preparatory Phase Checklist number(s) for this date. Each entry in this Section shall be accompanied with a corresponding Preparatory Phase Checklist.
 - e. Indicate if Initial Phase work was performed today (Yes/No checkboxes).
 - f. If Initial Phase work was performed today (including on-site and off-site work), identify its CPM Schedule Activity Number and Definable Feature or Element of Work. The Index Number is a cross reference to the Initial Phase Checklist. An example of the Index Number is: 0025-I01, where "0025" is the Quality Control Daily Report Number, "I" indicates Initial Phase, and "01" is the Initial Phase Checklist number(s) for this date. Each entry in this Section shall be accompanied with a corresponding Initial Phase Checklist.
 - g. Results of the Follow-up Phase inspections held today (including on-site and off-site work), including CPM Schedule Activity Number, location of definable feature or element of work, Specification Sections, etc. Indicate in the report for this definable feature or element of work that the work complies with the Contract Documents as approved in the Initial Phase, work complies with safety requirements, and that required testing and inspections have been performed. Include a list of who performed the tests and inspections.
 - h. List the rework items and deficiencies identified, but not corrected by close of business, along with its associated CPM Schedule Activity Number.
 - i. List the rework items and deficiencies corrected from the deficiency log along with the corrective action taken and its associated CPM Schedule Activity Number.
 - j. Include a "remarks" section in this report that shall contain pertinent information including but not limited to:
 - 1) Directions received.
 - 2) Quality control problem areas.
 - 3) Deviations from the QC plan.
 - 4) Construction deficiencies encountered.
 - 5) QC meetings held that day.
 - 6) Acknowledgement that record drawings, specifications, O & M data, and Warranty Manuals, have been updated and/or submitted.
 - 7) Corrective direction given by the QC Organization and corrective action taken by the Contractor.
 - 8) For each remark given, identify the CPM Schedule Activity Number that is associated with the remark.
 - 9) Quality Control Daily Report certification, signature, and date.
2. Superintendent Daily Report: This report shall be prepared anytime work or production is conducted or performed on or off site throughout the life of the contract. This Contractor's Production Report is the primary document utilized by the Superintendent for documentation of all construction activities performed by the Contractor and/or their Subcontractors. Sign-off sheets and Inspection logs will supplement and support this Daily Report. The reporting of work shall be identified by terminology consistent with the construction schedule and standard construction practices. Do not attach this report to the Quality Control Daily Report. The Superintendent Daily Reports are prepared, signed, and dated by an approved Superintendent and shall contain the following information:
- a. Identify Date of report, report number, Contract Number and Title, Task Order

- Number and Title, and Location.
- b. Identify the Contractor's name and the Superintendent's Name.
 - c. Identify whether work was performed A.M and/or P.M. Include Weather with Max Temperatures (F°) and Min. Temperatures (F°), precipitation, winds, humidity and dew point. Document any weather feature that may affect construction.
 - d. Enter Work Performed Today by CPM Schedule Activity Number, Work Location and Description of Work Activity, Employer, Number of workers, the Trade of the workers and the hours of work conducted per each trade.
 - e. List Total of Work Hours on the Jobsite. Cumulative Total of Work Hours from
 - f. Previous Report and Total of Work Hours from Start of Construction
 - g. Identify Job Safety: If Safety Meetings were Held. Was there any lost time Accidents? Was Crane/Man-lift/Trenching/Scaffold/HV Electric/High Work/or Hazmat Work accomplished? Was Hazardous Material or Waste Released into the Environment? List Safety Actions taken today. Safety Inspections Conducted. Have Safety Requirements been met?
 - h. Identify by submittal number all Equipment and/or Material received that day to be incorporated into the contract. Ensure all Equipment, Materials, and required quantities received have been inspected and approved in comparison to approved submittals. Give Description of Equipment and Material received; utilizing the Material Verification at delivery checklist and Material Location Reports as outlined in the Contractor's formal Material Receiving Inspection Program. The Superintendent shall ensure all materials, products; quantities and equipment incorporated in this contract are approved and are accepted before installation.
 - i. Identify Construction or Plant Equipment on the work site each day. Identify who owns the equipment. Describe the Type, Make, quantity, and Model of the Equipment and the hours utilized for each piece of equipment.
 - j. Remarks: Document construction activities, establishment, and maintenance of quality processes and procedures, observations, correction to deficiencies, and coordination of trades to ensure Quality Production. Document superintendent's utilization of sign-off sheets, inspection sheets, checklists, submittals, etc.... to instill and establish Quality. Identify production shortfalls and construction deficiencies and ways to correct these Deficiencies and short-falls on the Superintendent Daily Report. Document all deficiencies and corrections to Deficiencies on the Contractor's Deficiency Log maintained by the QC manager.
3. Preparatory Phase Report: File this report for each Definable Feature or Element of Work that is in the Preparatory Phase. The report shall be identified by terminology consistent with the construction schedule. Do not attach this report to the Quality Control Daily Report of the same date.
- a. Specification Section, date of report, Contract number and Task Order Number shall be filled out. Duplicate this information in the header of the second page of the report.
 - b. Definable Feature or Element of Work, CPM Schedule Activity Number and Index Number entry, and format shall match entry in the Preparatory Phase section of the Quality Control Daily Report. Duplicate this information in the header of the second page of the report.
 - c. Personnel Present: Indicate the number of hours of advance notice that was given to the COR and indicate (Yes/No checkboxes) whether or not the COR was notified. Indicate the Names of Preparatory Phase Meeting attendees, their position and their company affiliation. The meeting is conducted by the QCM and attended by the superintendent, all Subcontractors' foremen responsible for the definable feature or element of work, the Contractor's Independent 3rd Party Testing and Inspection Agencies, and the Contractor's Safety Representative. If all personnel are not

- present, cancel Preparatory Phase meeting.
 - d. Submittals: Indicate if submittals have been approved (Yes/No checkboxes), if no indicate what has not been submitted. If submittals are not approved, cancel Preparatory Phase meeting. Are materials on hand (Yes/No checkboxes) and if not, what items are missing. Check delivered material/equipment against approved submittals and comment as required.
 - e. Material Storage: Indicate if materials/equipment is stored properly (Yes/No checkboxes) and if not, what action is/was taken.
 - f. Specifications: Review and comment on Specification Paragraphs that describe the material/equipment, procedure for accomplishing the work and clarify any differences.
 - g. Preliminary Work & Permits: Ensure preliminary work is in accordance with the Contract Documents and necessary permits are on file, if not, describe the action taken.
 - h. Testing and Inspections: Identify who will perform tests and/or inspections, the frequency, and where tests and/or inspections are to occur. Review the testing and inspection plan, report abnormalities, and if the test and inspection facilities have been approved.
 - i. Discuss Control Procedures that shall be employed to consistently obtain the required specified quality; for example Sign-off sheets and Inspection logs.
 - j. Safety: Indicate if the job hazard analysis (JHA) has been approved (Yes/No checkboxes) and comment on the review of the applicable portions of the Construction Safety Manual. If the JHA is not approved, cancel Preparatory Phase meeting.
 - k. Meeting Comments: Note comments and remarks during the Preparatory Phase Meeting that was not addressed in previous sections of this checklist.
 - l. Other Items or Remarks: Note any other remarks or items that were a result of the Preparatory Phase.
 - m. QCM shall sign and date the report.
- 4. Initial Phase Checklist: Complete this report for each Definable Feature or Element of Work that is in the Initial Phase of Control. The report shall be identified by terminology consistent with the construction schedule. Do not attach this report to the Quality Control Daily Report of the same date.
 - a. Specification Section, date of report, Contract number and Task Order number shall be entered.
 - b. Definable Feature or Element of Work, CPM Schedule Activity Number and Index Number entry, and format shall match entry in the Initial Phase section of the Quality Control Daily Report.
 - c. Personnel Present: Indicate the number of hours of advance notice that was given to the COR and indicate (Yes/No checkboxes) whether or not the COR was notified. Indicate the Names of Initial Phase Meeting attendees, their position and company/GPO they are with. This meeting is conducted by the QCM and attended by the superintendent, all Subcontractors' foremen responsible for the definable feature or element of work, the Contractor's Independent 3rd Party Testing and Inspection Agencies, and the Contractor's Safety Representative. If all personnel are not present, cancel the Initial Phase meeting.
 - d. Control Procedures: Comment on control procedures identified at Preparatory Phase of Control and assurance that work is in accordance with plans, specifications, and submittals; for example, Sign-off sheets and Inspection logs. Control procedures not producing the required compliance shall be adjusted until the procedures consistently obtain the required quality.

- e. Preliminary Work: Ensure preliminary work being placed is in compliance and if not, what action is/was taken.
 - f. Workmanship: Identify whether the Standard of Control was established and accepted. Identify where the initial Standard of Control work is located; if a sample panel or Mock-up is required (Yes/No checkboxes); is the initial work the sample (Yes/No checkboxes); and if Yes, describe the panel location and precautions taken to preserve the sample.
 - g. Resolution: Comment on any differences and the resolutions reached.
 - h. Check Safety: Comment on the safety review of the job conditions.
 - i. Other: Note any other remarks or items that were a result of the Initial Phase.
 - j. QCM shall sign and date the report.
- D. Testing Log: As tests are performed, the QCM shall record, as a tracking device, all tests on the "Testing Log", the dates that tests were performed, the dates the test results were forwarded to the COR, remarks and acknowledgement that an accredited or Contracting Officer approved testing laboratory was used, the dates that all failing or nonconforming tests were corrected, accepted, or approved. Forward a copy of the updated "Test Log" upon request of the COR. Log shall be used as a management tool by the QCM to account and track all tests requirements of the QC Plan and contract specifications. Do not attach to the Quality Control Daily Report.
- E. Deficiency Log: The QCM shall maintain a comprehensive list of all work that does not comply with the contract, identifying what items need to be reworked, the date the item was originally discovered, the date the item shall be corrected by, and the date the item was corrected. All failed or nonconforming work, tests, and inspections will be documented in this Log. There is no requirement to report on the Deficiency Log a rework or deficient item that is corrected the same day it was discovered. Provide a copy of the comprehensive deficiency log weekly to the COR at the weekly progress meeting and at the end of the month for the Deficiency Report. The Contractor shall be responsible for including on this log all items needing rework including those identified by the COR and their staff. Do not attach to the Quality Control Daily Report.
- F. Code and Special Inspection Control Log: The Contractor will maintain and submit monthly a Code and Special Inspection Control Log, chronologically recording each Code and Special Inspection notification to the COR, tests and/or inspections performed under the VUSBC, or other agencies having jurisdiction on-site, including the nature of the test or inspection, the date performed, the results, approval or causes for rejection, corrective action taken, and dates of subsequent tests, inspections, and final acceptance.
- G. Test and Inspection Reports: The Contractor shall be responsible for establishing a system that shall record, on approved forms, all tests, and inspection results. Information on test and/or inspection designation, location, date of test and/or inspection, specification requirements, results and retest results, causes for rejection and recommended remedial actions shall be documented. A copy of the test and inspection results shall be sent directly from the Agency performing the testing services to the COR. The COR will be notified "IMMEDIATELY" of any failing tests and/or inspections. A certified technician performing all field tests and inspections shall sign all inspection reports. A certified testing laboratory manager performing all laboratory tests shall sign all test results. All test and/or inspection reports shall be reviewed, certified, and signed by a professional engineer, licensed in the Commonwealth of Virginia, as complying with the contract specifications. Do not attach to the Quality Control Daily Report. Submit within two (2) workdays after the test and/or inspection is performed:
- 1. Test and Inspection Reports shall be submitted within two (2) days after the test and/or inspection is performed.
 - 2. The QCM shall submit at the end of each month, as part of the Monthly Quality Control
- H. Monthly Summary Report of Tests:

- Summary Report, a current and up-to-date Monthly Summary Report of Tests and Inspections, per each Definable Feature or Element of Work, that includes and accounts for all testing and inspections performed to date for that specific Definable Feature or Element of Work in that month. Submit with each Monthly Summary Report of Tests and Inspections, all testing reports, and documentation pertaining to that month's testing and inspections.
3. The Monthly Summary Report of Tests and Inspections will summarize, in detail, all information required of a Test and/or Inspection Report and contract specifications.
 4. A Professional Engineer, licensed in the District of Columbia, shall review, certify, and sign all Monthly Summary Report of Tests and Inspections as complying with the contract specifications.
- H. Inspection Log and Signoff Sheets: The Contractor's superintendent shall establish, coordinate, and maintain with all trades and personnel, for each Definable Feature or Element of Work, a system of inspections and signoff sheets to certify that all work under the superintendent's control has been coordinated, constructed, and installed according to the plans and specifications. All work will be documented as being inspected and signed-off by the Contractor before starting and performing construction on the next Definable Feature or Element of Work. These inspections and sign-off sheets shall be incorporated into the Phases of Control.
- I. Monthly Deficiency Report: The Contractor shall submit a monthly comprehensive deficiency report to COR identifying all nonconforming work, substandard tests and inspections identified during the contract period including the nature of the test or inspection, location and nature of defects, causes for rejection, and remedial actions taken or proposed for any open items on prior deficiency reports including the date scheduled for resolution of the item. Do not attach to the Quality Control Daily Report.
- J. Record Drawings: The QCM is required to ensure the record drawings, required by Division 01 Section "Project Record Documents," are kept current on a daily basis and marked to show deviations which have been made from the construction drawings. Ensure each deviation has been identified with the appropriate modifying documentation (e.g. CN No., Modification No., Request for Information No., etc.). The QCM shall initial each deviation and each revision. Upon completion of work, the QCM shall furnish a certificate attesting to the accuracy of the record drawings prior to submission to the COR.
- K. Operation, Maintenance, and Warranty Manuals: The QCM shall ensure that the Operation and Maintenance data required by Division 01 Section "Operation and Maintenance Data" and the Warranties specified in Division 01 Section "Project Closeout" are inserted on a daily basis in the appropriate sections of the approved formatted manuals after they have been approved by the COR.
- L. Materials Receiving Inspection Report: The Contractor shall establish a formal materials receiving inspection program to verify material compliance to approved Shop Drawings, approved submittals, and the contract plans and specifications. This report shall be cumulative, showing materials previously reported plus items recently delivered. Include with this report a statement of progress on and delivery dates for all materials or items of equipment being fabricated or stored away from the building site. Do not attach to the Quality Control Daily Report.
- M. Reports from the QC Specialist(s): Reports are required for each day that work is performed in their area of responsibility. QC specialist reports shall include the same documentation requirements as the Quality Control Daily Report for their area of responsibility. QC specialist reports are to be prepared, signed and dated by the QC specialists and shall not be attached to

the Quality Control Daily Report prepared for the same day.

1.20 NOTIFICATION OF NON-COMPLIANCE

- A. The COR will notify the Contractor of any detected non-compliance with the foregoing requirements. The Contractor shall take immediate corrective action after the receipt of such notice. Such notice, when delivered to the Contractor via the GPO provided Oracle Primavera Unifier project management system shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly the Contracting Officer may:
 - 1. Issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall make no part of the time lost, due to such stop orders, the subject of a claim for extension of time for excess costs or damages.
 - 2. Repair, replace, or otherwise remedy the defective work at the Contractor's expense. Cost incurred by the GPO to correct defective work shall be deducted from the total amount due the Contractor.
 - 3. Withhold an amount from the payment due the Contractor as may be deemed necessary at the discretion of the Contracting Officer.
- B. Terminate the Contractor's right to proceed for Default after providing required notice.
- C. In cases where implementation of the Quality Control Program does not comply with the Contractor's Quality Control Plan, the Contract Documents, or the Contractor fails to properly operate and maintain an effective Quality Control Program, the Contracting Officer may:
 - 1. Order the Contractor to replace ineffective or unqualified Quality Control Personnel or Subcontractors.
 - 2. Issue an order stopping all or part of the work until acceptable personnel are on site and a new Quality Control Plan is approved by the COR. The Contractor shall make no part of the time lost due to such stop orders the subject of a claim for extension of time or for excess costs or damages.
 - 3. Take a credit from the contract for Quality Control Activities not performed.
 - 4. Terminate the Contractor's right to proceed for Default after providing required notice.
- D. The Contractor shall maintain a detailed record of every non-compliance and corrective action taken.
- E. Non-Compliance Notification: The COR will use the GPO provided web-based Oracle Primavera Unifier project management system (Unifier) to notify the Contractor on Non-Compliance work or material. Acknowledgement and corrective action by the Contractor shall be transmitted to the COR through Unifier. The GPO will provide the Contractor a Unifier license(s) and training.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION 01 40 00

SECTION 01 42 00 - REFERENCES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section defines many of the terms used elsewhere in the Construction Documents and lists complete names and telephone numbers for many of the associations and agencies identified elsewhere in the Construction Documents by their acronym.
- B. Abbreviations, where not defined in the Construction Documents, will be interpreted by the Contracting Officer to mean the normal construction industry terminology.
- C. Plural words will be interpreted as singular and singular words will be interpreted as plural where applicable for context of the Construction Documents.

1.3 DEFINITIONS

- A. General: Certain terms used in the Construction Documents are defined generally in this Section. Definitions and explanations contained in this Section are not necessarily either complete or exclusive, but are general for the Work to the extent that they may not be stated more explicitly in another element of the Construction Documents.
- B. Award: The acceptance, by the GPO, of the Contractor's proposal for a Construction Work Package.
- C. "Install": Operations at the Jobsite including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, connecting, finishing, curing, protecting, cleaning, and similar operations.
- D. "Provide": Furnish and install, complete and ready for the intended use.
- E. "Installer": The Contractor or another entity engaged by the Contractor as an employee, Subcontractor, or Sub-Subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
- F. Using a term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of the corresponding generic name.
- G. "Experienced": When used with an entity, "experienced" means having successfully completed a minimum of ten previous projects similar in size and scope to this Program or Construction

Work Package; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

- H. Specifications: That portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work. Divisions 00 and 01 of the specifications include requirements for administration and performance of the Work. Divisions 02 through 48 of the specifications include technical requirements for the materials, equipment, systems, standards, and workmanship.
- I. Factory-Authorized Service Representative: An authorized representative of a manufacturer who is trained and approved by the manufacturer to inspect and approve the installation of manufacturer's products and that are similar in material, design, and extent to those indicated for this Project and who is authorized by the manufacturer to confirm the issuance of appropriate warranties.

1.4 INDUSTRY STANDARDS

- A. Applicability of Standards: Unless the Construction Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Construction Documents to the extent referenced. Such standards are made a part of the Construction Documents by reference.
- B. Publication Dates: Comply with standards in effect as of date of the Construction Documents, unless otherwise indicated.
- C. Conflicting Requirements: Refer to Division 01 Section "Quality Requirements" for additional information regarding conflicting requirements.

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

- D. Copies of Standards: Each entity engaged in construction on the Construction Work Package shall be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Construction Documents.

Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

- E. Abbreviations and Acronyms for Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Construction Documents, they shall mean the recognized name of the standards and regulations in the following list. Names, telephone numbers, and Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Construction Documents.

ADAAG Americans with Disabilities Act (ADA)

(800) 872-2253

	Accessibility Guidelines for Buildings and Facilities Available from Access Board www.access-board.gov	(202) 272-0080
CFR	Code of Federal Regulations Available from Government Printing Office www.access.gpo.gov/nara/cfr	(888) 293-6498 (202) 512-1530
CRD	Handbook for Concrete and Cement Available from Army Corps of Engineers Waterways Experiment Station www.wes.army.mil	(601) 634-2355
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point www.dodssp.daps.mil	(215) 697-6257
DSCC	Defense Supply Center Columbus (See FS)	
FED-STD	Federal Standard (See FS)	
FS	Federal Specification Available from Department of Defense Single Stock Point. www.dodssp.daps.mil	(215) 697-6257
	Available from General Services Administration www.fss.gsa.gov	(202) 501-1021
	Available from National Institute of Building Sciences www.nibs.org	(202) 289-7800
FTMS	Federal Test Method Standard (See FS)	
ICC-ES	ICC Evaluation Service, Inc. www.icc-es.org	(800) 423-6587
MIL	See MILSPEC	
MS MIL	See MILSPEC	

MILSPEC	Military Specification and Standards Available from Department of Defense Single Stock Point www.dodssp.daps.mil	(215) 697-6257
MUTCD	Manual on Uniform Traffic Control Devices Department of Transportation Federal Highway Administration (See FHA. Located in Paragraph Federal Government Agencies”).	
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov	(800) 872-2253 (202) 272-0080

ABBREVIATIONS AND ACRONYMS

Industry Organizations:

AA	Aluminum Association, Inc. (The) www.aluminum.org	(202) 862-5100
AAADM	American Association of Automatic Door Manufacturers www.aaadm.com	(216) 241-7333
AABC	Associated Air Balance Council www.aabchq.com	(202) 737-0202
AAMA	American Architectural Manufacturers Association www.aamanet.org	(847) 303-5664
AASHTO	American Association of State Highway and Transportation Officials http://www.transportation.org	(202) 624-5800
AATCC	American Association of Textile Chemists and Colorists (The) www.aatcc.org	(919) 549-8141
ABMA	American Bearing Manufacturers Association www.abma-dc.org	(202) 367-1155
ACI	ACI International (American Concrete Institute) www.aci-int.org	(248) 848-3700
ACPA	American Concrete Pipe Association http://www.concrete-pipe.org	(972) 506-7216

AEIC	Association of Edison Illuminating Companies, Inc. (The) www.aeic.org	(205) 257-2530
AF&PA	American Forest & Paper Association www.afandpa.org	(800) 878-8878 (202) 463-2700
AGA	American Gas Association www.aga.org	(202) 824-7000
AGC	Associated General Contractors of America (The) www.agc.org	(703) 548-3118
AHA	American Hardboard Association (Now part of CPA)	
AHAM	Association of Home Appliance Manufacturers www.aham.org	(202) 872-5955
AI	Asphalt Institute http://www.asphaltinstitute.org	(859) 288-4960
AIA	American Institute of Architects (The) www.aia.org	(800) 242-3837 (202) 626-7300
AISC	American Institute of Steel Construction www.aisc.org	(800) 644-2400 (312) 670-2400
AISI	American Iron and Steel Institute www.steel.org	(202) 452-7100
AITC	American Institute of Timber Construction http://www.aitc-glulam.org	(303) 792-9559
ALCA	Associated Landscape Contractors of America www.alca.org	(800) 395-2522 (703) 736-9666
ALSC	American Lumber Standard Committee, Incorporated www.alsc.org	(301) 972-1700
AMCA	Air Movement and Control Association International, Inc. www.amca.org	(847) 394-0150
ANSI	American National Standards Institute www.ansi.org	(202) 293-8020
AOSA	Association of Official Seed Analysts Http://www.aosaseed.com	(505) 522-1437

APA	APA - The Engineered Wood Association http://www.apawood.org	(253) 565-6600
APA	Architectural Precast Association http://www.archprecast.org	(239) 454-6989
API	American Petroleum Institute www.api.org	(202) 682-8000
ARI	Air-Conditioning & Refrigeration Institute www.ari.org	(703) 524-8800
ARMA	Asphalt Roofing Manufacturers Association http://www.asphaltroofing.org	(202) 207-0917
ASCE	American Society of Civil Engineers www.asce.org	(800) 548-2723 (703) 295-6300
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers www.ashrae.org	(800) 527-4723 (404) 636-8400
ASME	ASME International (The American Society of Mechanical Engineers International) www.asme.org	(800) 843-2763 (212) 591-7722
ASSE	American Society of Sanitary Engineering http://www.asphaltroofing.org	(440) 835-3040
ASTM	ASTM International (American Society for Testing and Materials International) www.astm.org	(610) 832-9585
AWCI	AWCI International (Association of the Wall and Ceiling Industries International) www.awci.org	(703) 534-8300
AWCMA	American Window Covering Manufacturers Association (See WCSC)	
AWI	Architectural Woodwork Institute www.awinet.org	(800) 449-8811 (703) 733-0600
AWPA	American Wood-Preservers' Association www.awpa.com	(334) 874-9800

AWS	American Welding Society www.aws.org	(800) 443-9353 (305) 443-9353
AWWA	American Water Works Association www.awwa.org	(800) 926-7337 (303) 794-7711
BHMA	Builders Hardware Manufacturers Association http://www.buildershardware.com	(212) 297-2122
BIA	Brick Industry Association (The) www.bia.org	(703) 620-0010
BICSI	Building Industry Consulting Service International, Inc. www.bicsi.org	(800) 242-7405 (813) 979-1991
BIFMA	BIFMA International (Business and Institutional Furniture Manufacturer's Association International) www.bifma.com	(616) 285-3963
BISSC	Baking Industry Sanitation Standards Committee www.bissc.com	(773) 761-4100
CCC	Carpet Cushion Council http://www.asphaltroofing.org	(203) 637-1312
CCFSS	Center for Cold-Formed Steel Structures http://www.asphaltroofing.org	(573) 341-4471
CDA	Copper Development Association Inc. www.copper.org	(800) 232-3282 (212) 251-7200
CFFA A	Chemical Fabrics & Film Association, Inc. http://www.asphaltroofing.org Compressed Gas Association www.cganet.com	(216) 241-7333 (703) 788-2700
CGSB	Canadian General Standards Board http://www.asphaltroofing.org	(800) 665-2472 (819) 956-0425
CIMA	Cellulose Insulation Manufacturers Association http://www.asphaltroofing.org	(888) 881-2462 (937) 222-2462

CISCA	Ceilings & Interior Systems Construction Association www.cisca.org	(630) 584-1919
CISPI	Cast Iron Soil Pipe Institute www.cispi.org	(423) 892-0137
CLFMI	Chain Link Fence Manufacturers Institute http://www.asphaltroofing.org	(301) 596-2583
CPA	Composite Panel Association www.pbmdf.com	(301) 670-0604
CPPA	Corrugated Polyethylene Pipe Association http://www.cppa-info.org	(800) 510-2772 (202) 462-9607
CRI	Carpet & Rug Institute (The) http://www.carpet-rug.com	(800) 882-8846 (706) 278-3176
CRSI	Concrete Reinforcing Steel Institute www.crsi.org	(847) 517-1200
CSA	CSA International (Formerly: IAS - International Approval Services) http://www.csa-international.org	(800) 463-6727 (416) 747-4000
CSI	Construction Specifications Institute (The) www.csinet.org	(800) 689-2900 (703) 684-0300
CSSB	Cedar Shake & Shingle Bureau http://www.cedarbureau.org	(604) 820-7700
CTI	Cooling Technology Institute (Formerly: Cooling Tower Institute) www.cti.org	(281) 583-4087
DHI	Door and Hardware Institute www.dhi.org	(703) 222-2010
EIA	Electronic Industries Alliance www.eia.org	(703) 907-7500
EIMA	EIFS Industry Members Association http://www.eima.com/	(800) 294-3462 (770) 968-7945
EJCDC	Engineers Joint Contract Documents Committee www.asce.org	(800) 548-2723 (703) 295-6300

EJMA	Expansion Joint Manufacturers Association, Inc. www.ejma.org	(914) 332-0040
ESD	ESD Association www.esda.org	(315) 339-6937
FCI	Fluid Controls Institute http://www.asphaltroofing.org	(216) 241-7333
FGI	Fabricated Geomembrane Institute www.fabricatedgeomembrane.com	(217) 333-3929
FMG	FM Global (Formerly: FM - Factory Mutual System) www.fmglobal.com	(401) 275-3000
FRSA	Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. www.floridarooft.com	(407) 671-3772
FSA	Fluid Sealing Association www.fluidsealing.com	(610) 971-4850
FSC	Forest Stewardship Council www.fscoax.org	52 951 5146905
GA	Gypsum Association www.gypsum.org	(202) 289-5440
GANA	Glass Association of North America www.glasswebsite.com	(785) 271-0208
GS	Green Seal www.greenseal.org	(202) 872-6400
GSI	Geosynthetic Institute www.geosynthetic-institute.org	(610) 522-8440
HI	Hydraulic Institute www.pumps.org	(888) 786-7744 (973) 267-9700
HI		(908) 464-8200
HMMA	Hydronics Institute www.gamanet.org Hollow Metal Manufacturers Association (See NAAMM)	

HPVA	Hardwood Plywood & Veneer Association www.hpva.org	(703) 435-2900
HPW	H. P. White Laboratory, Inc. www.hpwhite.com	(410) 838-6550
IAS	International Approval Services (See CSA)	
ICEA	Insulated Cable Engineers Association, Inc. www.icea.net	(770) 830-0369
ICRI	International Concrete Repair Institute, Inc. www.icri.org	(847) 827-0830
IEC	International Electrotechnical Commission www.iec.ch	41 22 919 02 11
IEEE	Institute of Electrical and Electronics Engineers, Inc. (The) www.ieee.org	(212) 419-7900
IESNA	Illuminating Engineering Society of North America www.iesna.org	(212) 248-5000
IGCC	Insulating Glass Certification Council www.igcc.org	(315) 646-2234
IGMA	Insulating Glass Manufacturers Alliance (The) www.igmaonline.org	(613) 233-1510
ILI	Indiana Limestone Institute of America, Inc. www.iliai.com	(812) 275-4426
ISO	International Organization for Standardization www.iso.ch	41 22 749 01 11
ISSFA	International Solid Surface Fabricators Association www.issfa.net	(702) 567-8150
ITS	Intertek www.intertek.com	(800) 345-3851 (607) 753-6711
ITU	International Telecommunication Union www.itu.int/home	41 22 730 51 11
KCMA	Kitchen Cabinet Manufacturers Association www.kcma.org	(703) 264-1690

LMA	Laminating Materials Association www.lma.org	(201) 664-2700
LPI	Lightning Protection Institute www.lightning.org	(800) 488-6864 (847) 577-7200
MBMA	Metal Building Manufacturers Association www.mbma.com	(216) 241-7333
MFMA	Maple Flooring Manufacturers Association www.maplefloor.org	(847) 480-9138
MFMA	Metal Framing Manufacturers Association www.metalframingmfg.org	(312) 644-6610
MH	Material Handling Industry of America (See MHIA)	
MHIA	Material Handling Industry of America www.mhia.org	(800) 345-1815 (704) 676-1190
MIA	Marble Institute of America www.marble-institute.com	(440) 250-9222
MPI	Master Painters Institute www.paintinfo.com	(888) 674-8937
MSS	Manufacturers Standardization Society of The Valve and Fittings Industry Inc. www.mss-hq.com	(703) 281-6613
NAAMM	National Association of Architectural Metal Manufacturers www.naamm.org	(312) 332-0405
NACE	NACE International (National Association of Corrosion Engineers International) www.nace.org	(281) 228-6200
NADCA	National Air Duct Cleaners Association www.nadca.com	(202) 737-2926
NAIMA	North American Insulation Manufacturers Association (The) www.naima.org	(703) 684-0084
NBGQA	National Building Granite Quarries Association, Inc. www.nbgqa.com	(800) 557-2848

NCMA	National Concrete Masonry Association www.ncma.org	(703) 713-1900
NCPI	National Clay Pipe Institute www.ncpi.org	(262) 248-9094
NCTA	National Cable & Telecommunications Association www.ncta.com	(202) 775-3550
NEBB	National Environmental Balancing Bureau www.nebb.org	(301) 977-3698
NECA	National Electrical Contractors Association http://www.necanet.org/	(301) 657-3110
NeLMA	Northeastern Lumber Manufacturers' Association www.nelma.org	(207) 829-6901
NEMA	National Electrical Manufacturers Association www.nema.org	(703) 841-3200
NETA	InterNational Electrical Testing Association www.netaworld.org	(303) 697-8441
NFPA	NFPA www.nfpa.org	(800) 344-3555 (617) 770-3000
NFRC	National Fenestration Rating Council www.nfrc.org	(301) 589-1776
NGA	National Glass Association www.glass.org	(703) 442-4890
NHLA	National Hardwood Lumber Association www.natlhardwood.org	(800) 933-0318 (901) 377-1818
NLGA	National Lumber Grades GPO www.nlga.org	(604) 524-2393
NOFMA	National Oak Flooring Manufacturers Association www.nofma.org	(901) 526-5016
NRCA	National Roofing Contractors Association www.nrca.net	(800) 323-9545 (847) 299-9070
NRMCA	National Ready Mixed Concrete Association	(888) 846-7622

	www.nrmca.org	(301) 587-1400
NSF	NSF International (National Sanitation Foundation International) www.nsf.org	(800) 673-6275 (734) 769-8010
NSSGA	National Stone, Sand & Gravel Association www.nssga.org	(800) 342-1415 (703) 525-8788
NTMA	National Terrazzo & Mosaic Association, Inc. www.ntma.com	(800) 323-9736 (540) 751-0930
NTRMA	National Tile Roofing Manufacturers Association (See RTI)	
NWWDA	National Wood Window and Door Association (See WDMA)	
OPL	Omega Point Laboratories, Inc. www.opl.com	(800) 966-5253 (210) 635-8100
PCI	Precast/Prestressed Concrete Institute www.pci.org	(312) 786-0300
PDCA	Painting & Decorating Contractors of America www.pdca.com	(800) 332-7322 (314) 514-7322
PDI	Plumbing & Drainage Institute (800) 589-8956 www.pdionline.org	(978) 557-0720
PTI	Post-Tensioning Institute (602) 870-7540 www.post-tensioning.org	
RCSC	Research Council on Structural Connections (800) 644-2400 www.boltcouncil.org (312) 670-2400	
RFCI	Resilient Floor Covering Institute (301) 340-8580 www.rfci.com	
RIS	Redwood Inspection Service (888) 225-7339 calredwood.org	(415) 382-0662
RTI	Roof Tile Institute (Formerly: NTRMA - National Tile Roofing Manufacturers Association) www.ntrma.org	(312) 670-4177
SAE	SAE International (724) 776-4841 www.sae.org	
SDI	Steel Deck Institute (847) 462-1930 www.sdi.org	
SDI	Steel Door Institute (440) 899-0010 www.steeldoor.org	
SEFA	Scientific Equipment and Furniture Association (516) 294-5424 www.sefalabs.com	
SGCC	Safety Glazing Certification Council (315) 646-2234 www.sgcc.org	

SIA	Security Industry Association www.sefalabs.com	(703) 683-2075
SIGMA	Sealed Insulating Glass Manufacturers Association (See IGMA)	
SJI	Steel Joist Institute (843) 626-1995 www.steeljoist.org	
SMA	Screen Manufacturers Association (561) 533-0991 www.smacentral.org	
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association www.smacentral.org	(703) 803-2980
SPFA	Spray Polyurethane Foam Alliance (Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) www.sprayfoam.org	(800) 523-6154
SPIB	Southern Pine Inspection Bureau (The) www.spib.org	(850) 434-2611
SPI/SPFD	Society of the Plastics Industry, Inc. (The) Spray Polyurethane Foam Division (See SPFA)	
SPRI	SPRI (Single Ply Roofing Institute) www.spri.org	(781) 647-7026
SSINA	Specialty Steel Industry of North America www.ssina.com	(800) 982-0355 (202) 342-8630
SSPC	SSPC: The Society for Protective Coatings www.sspc.org	(877) 281-7772 (412) 281-2331
STI	Steel Tank Institute www.steeltank.com	(847) 438-8265
SWI	Steel Window Institute www.steelwindows.com	(216) 241-7333
SWRI	Sealant, Waterproofing, & Restoration Institute www.swrionline.org	(816) 472-7974
TCA	Tile Council of America, Inc. www.tileusa.com	(864) 646-8453

TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance www.tiaonline.org	(703) 907-7700
TMS	The Masonry Society www.masonrysociety.org	(303) 939-9700
TPI	Truss Plate Institute, Inc. www.tpinst.org	(608) 833-5900
TPI	Turfgrass Producers International www.turfgrasssod.org	(800) 405-8873 (847) 705-9898
UL	Underwriters Laboratories Inc. www.ul.com	(800) 285-4476 (847) 272-8800
UNI	Uni-Bell PVC Pipe Association www.uni-bell.org	(972) 243-3902
USGBC	U.S. Green Building Council www.usgbc.org	(202) 828-7422
WASTEC	Waste Equipment Technology Association www.wastec.org	(800) 424-2869 (202) 244-4700
WCLIB	West Coast Lumber Inspection Bureau www.wclib.org	(800) 283-1486 (503) 639-0651
WCMA	Window Covering Manufacturers Association (See WCSC)	
WCSC	Window Covering Safety Council (Formerly: WCMA - Window Covering Manufacturers Association) www.windowcoverings.org	(800) 506-4636 (212) 661-4261
WDMA	Window & Door Manufacturers Association (Formerly: NWWDA - National Wood Window and Door Association) www.wdma.com	(800) 223-2301 (847) 299-5200
WMMPA	Wood Moulding & Millwork Producers Association www.wmmpa.com	(800) 550-7889 (530) 661-9591

Code Agencies:

(909) 472-4100

IAPMO International Association of Plumbing and Mechanical Officials
www.iapmo.org

ICBO International Conference of Building Officials (See ICC)

ICBO ES ICBO Evaluation Service, Inc.
(See ICC-ES)

(703) 931-4533

ICC International Code Council
(Formerly: CABO - Council of American Building Officials)
www.iccsafe.org

ICC-ES ICC Evaluation Service, Inc.
www.icc-es.org

(800) 423-6587
(562) 699-0543

C. Federal Government Agencies:

CE Army Corps of Engineers www.usace.army.mil
CPSC Consumer Product Safety Commission
www.cpsc.gov

(800) 638-2772
(301) 504-0990

DOC Department of Commerce
www.doc.gov

(202) 482-2000

EPA Environmental Protection Agency www.epa.gov

(202) 260-2090

FAA Federal Aviation Administration www.faa.gov

(202) 366-4000

FCC Federal Communications Commission www.fcc.gov

(202) 225-5322

FDA Food and Drug Administration www.fda.gov

(888) 463-6332

FHA Federal Highway Administration www.fhwa.dot.gov

(410) 962-0093

GSA General Services Administration
www.gsa.gov

(202) 708-5082

HUD Department of Housing and Urban Development www.hud.gov

(202) 708-1112

LBL	Lawrence Berkeley Laboratory National Laboratory www.lbl.gov	(510) 486-4000
NIST	National Institute of Standards and Technology www.nist.gov	(301) 975-6478
OSHA	Occupational Safety & Health Administration www.osha.gov	(800) 321-6742 (202) 693-1999
PBS	Public Building Service (See GSA)	
PHS	Office of Public Health and Science phs.os.dhhs.gov	(202) 690 7694
TRB	Transportation Research Board www.nas.edu/trb	(202) 334-2934
TSA	Transportation Security Administration www.tsa.gov/public/index.jsp	1(866)-289-9673
USDA	Department of Agriculture www.usda.gov	(202) 720-2791
USPS	United States Postal Service www.usps.com	(202) 268-2000

D. State Government Agencies:

DCR	Virginia Department of Conservation and Recreation http://www.dcr.state.va.us	(804) 786-1712
VDH	Virginia Department of Health Culpepper District www.vdh.state.va.us	(540) 829-7340
USBC	The Virginia Statewide Building Code (USBC) The Commonwealth of Virginia – Uniform Statewide Building Code	(804) 371- 7160

VDHCD

Virginia Department of Housing and Community
Development
Division of Building and Fire Regulation
501 North 2nd Street
Richmond, VA 23219-1321

VDOT

(703) 383-8368

Virginia Department of Transportation www.virginiadot.org

VDEQ

Virginia Department of Environmental Quality
www.deq.state.va.us

1-800-592-5482

1.5 GOVERNING REGULATIONS/AUTHORITIES

- A. Contact authorities having jurisdiction directly for information and decisions having a bearing on the Work. Names and addresses are subject to change; they are believed to be but are not assured to be accurate and up to date as of the date of the Construction Documents.
- B. Codes: The Contractor shall adhere to all applicable portions of code standards and specifications in the construction of the work. Unless otherwise noted (reference Division 01 Section "Quality Requirements"), the GPO will review the Contractor's submittals and construction of the work for code compliance. The GPO's acceptance of completed construction does not relieve the Contractor from strict compliance with all applicable regulations and codes.
- C. Standards that influence the construction of the project include, but are not limited to, all applicable federal and DC laws, all applicable codes, rules, regulations and standards applicable to this project.

PART 2 PART 2 - PRODUCTS (Not Used)

PART 3 PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes requirements for temporary facilities and controls, including temporary utilities, support facilities, security, and protection facilities for the Contractor's staging area.
- B. Temporary utilities include, but are not limited to, the following:
 - 1. Heating and cooling facilities.
 - 2. Ventilation.
 - 3. Electric power service.
 - 4. Telephone and other communication services.
- C. Support facilities include, but are not limited to, the following:
 - 1. Dewatering facilities and drains.
 - 2. Program and Task Order identification and temporary signs.
 - 3. Waste disposal facilities.
 - 4. Field offices.
 - 5. Storage and fabrication sheds.
 - 6. Lifts and hoists.
 - 7. Temporary elevator usage.
 - 8. Temporary stairs.
 - 9. Construction aids and miscellaneous services and facilities.
 - 10. COR trailer.
- D. Security and protection facilities include, but are not limited to, the following:
 - 1. Environmental protection.
 - 2. Pest control.
 - 3. Site enclosure fence.
 - 4. Security enclosure and lockup.
 - 5. Barricades, warning signs, and lights.
 - 6. Covered walkways.
 - 7. Temporary enclosures.
 - 8. Temporary partitions.
 - 9. Fire protection.
- E. Related Sections include the following:
 - 1. Division 01 Section "Submittals" for procedures for submitting copies of implementation

- and termination schedule and utility reports.
2. Divisions 02 through 28 Sections for temporary heat, ventilation, and humidity requirements for products used in those Sections.

1.3 DEFINITIONS

- A. Permanent Enclosure: As determined by the COR, permanent or temporary roofing is complete, insulated, and weather tight; exterior walls are insulated and weather tight; and all openings are closed with permanent construction or substantial temporary closures.

1.4 USE CHARGES

- A. General: Temporary utilities are available from the GPO at no charge unless otherwise noted. Provide necessary labor and materials to connect to the GPO's utilities at points designated by the COR and extend utilities to trailers, offices, sheds, etc.:
 1. Submit for approval, and provide meters for water, natural gas, electricity, and each other utility used for the Work. Supply utilities to Subcontractors' temporary facilities through the Contractor's meters. The requirement to provide meters for utilities does not imply that the Contractor will be charged for these utilities, except under provisions outlined in this and other Sections.
 2. Report consumption of each utility to the COR each month. The Contractor is expected to consume reasonable amounts of each utility. Should the Contractor, in the COR's opinion, use excessive amounts of any utility or waste a utility, the Contractor may be required to pay for temporary utilities.
- B. Allow other entities to use temporary services and facilities without cost, including, but are not limited to, the following:
 1. The GPO's construction forces.
 2. Contractor's for build-out of tenant and concession spaces.
 3. COR.
 4. Architect/Engineer.
 5. Testing agencies.
 6. Personnel of authorities having jurisdiction.

1.5 SUBMITTALS

- A. Shop Drawings: Submit for the GPO's review and approval, site plans indicating all temporary facilities, support and security; utility connections and traffic flows. Provide detailed drawings of utility connections and special facilities. Building Code review and approval of shop drawings for temporary facilities is required.
- B. Temporary Utility Reports: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities at both staging area and the Jobsite. Make all structures weather proof when heated and air-conditioned. The Contractor may be required to pay for temporary utility usage if heated and cooled structures are not properly sealed and weather- proofed.

- C. Implementation and Termination Schedule: Within 15 calendar days of date established for submittal of the Contractor's first CPM Schedule, submit a schedule indicating implementation and termination of each temporary utility.
- D. Samples for Verification: For protective wall treatment for temporary partitions as follows:
 - 1. Protective Wall Covering: 24 inches square, mounted on gypsum wallboard with moldings and butt joints. Include 12-inch-long samples of inside and outside corner moldings.
 - 2. Bumper Guards: 12 inches long including fastening devices and showing end treatment.
 - 3. Corner Guards: 8 inches long, in full-size profile of each type.

1.6 QUALITY ASSURANCE

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, that include but are not limited to, the following:
 - 1. Building Code requirements.
 - 2. Health and safety regulations.
 - 3. Police and Fire Department regulations.
 - 4. Environmental protection regulations.
 - 5. ADA Compliance: All temporary facilities shall be ADA compliant.
- B. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities," and NFPA 241.
 - 1. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
 - 2. Electrical Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electrical service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for the GPO's Building Codes/Environmental Department to test and inspect each temporary utility before use. Coordinate with the GPO's Building Codes/Environmental Department for requirements for certifications, permits, and inspections.
 - 1. Obtain permits from the GPO's Building Codes/Environmental Department for temporary construction and temporary utilities.
- D. Fire-retardant and Flame Spread Requirements: Unless otherwise noted, fire – retardant treat all wood and wood composition products utilized in the Project and preservative treat all wood utilized on the exterior of any building. Preservative treat all wood utilized on other items indicated or specified with preservative treatment. Provide lumber and plywood with an Underwriters' Laboratory (UL) stamp certifying a value of 25 or less flame spread and a value of 200 or less smoke development. Fire retardant lumber shall not be ripped or milled.

1.7 JOBSITE CONDITIONS

- A. Temporary Utilities: At earliest feasible time, when acceptable to COR, change over from use of temporary service to use of permanent service:
 - 1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during

its use as a construction facility before the GPO's acceptance, regardless of previously assigned responsibilities.

- B. Conditions of Use: The following conditions apply to use of temporary services, permanent services and facilities by all parties engaged in the Work:
1. Keep temporary services and facilities clean and neat.
 2. Relocate temporary services and facilities as required by progress of the Work.
 3. Take necessary fire-prevention measures.
 4. Do not overload facilities.
 5. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

1.8 PARKING PROGRAM FOR CONTRACTOR PERSONNEL

- A. On-GPO parking for the Contractor's personnel is limited. The Contractor is responsible for requesting permits and pay when applicable for Contractor personnel to include all Subcontractors, consultants and other persons working at the Jobsite.
- B. If off-site parking or storage of materials and equipment is required, the Contractor will be responsible for the maintenance, security, safety, and operation of these facilities off-site parking or storage of materials and equipment is required. Transportation of materials, equipment, and personnel to the Work site is the responsibility of the Contractor.
- C. The Contractor is responsible for busing his employees from the offsite parking lot to the Contractor's Staging areas or work areas.

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by the COR. Provide materials suitable for use intended. All materials for use, whether for temporary or permanent use, must be submitted for information.
- B. Pavement: Comply with applicable specifications and industry standards for temporary asphalt and or concrete paving.
- C. Lumber and Plywood: Comply with applicable specification and industry standards for lumber and plywood used for temporary work.
- D. Gypsum Board: Minimum 1/2 inch thick by 48 inches wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36.
- E. Insulation: Un-faced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively.
- F. Paint: Comply with application specification and industry standards for Exterior Painting and Interior Painting used for temporary work.

- G. Tarpaulins: Fire-resistive labeled with flame-spread index of 15 or less.
- H. Water: Potable.
- I. Temporary Fuel Tanks: For requirements for temporary fuel tanks see the specification for "Storm Water Pollution Protection Plan." Comply with applicable safety and environmental regulations for temporary surface fuel tanks. Location and installation of tanks will be subject to review and approval of the GPO's Environmental Department, the COR and the GPO's Fire Marshal.

2.2 EQUIPMENT

- A. General: Provide new equipment suitable for use intended. Undamaged, previously used equipment in serviceable condition may be used for temporary service if submitted and approved. All equipment for use, whether for temporary or permanent use, must be submitted for information.
- B. Field Offices: Prepare and submit for approval shop drawings for the supply and installation of prefabricated, modular-office trailers with lockable entrances, operable windows, and serviceable finishes; heated and air conditioned; code-certified prefabricated entrance; skirting; on foundations adequate for normal loading, and provided with proper tie-downs. The shop drawings must be prepared and signed by a Professional Engineer registered in Virginia. In addition, submit shop drawings for the electric service prepared and signed by a Professional Engineer or Master Electrician licensed in Virginia.
- C. Self-Contained Toilet Units: Single-occupant units of chemical, aerated re-circulation or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- D. Drinking-Water Fixtures: Drinking-water fountains, or containerized, tap-dispenser, bottled water drinking-water units or equivalent shall be provided:
 - 1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.
- E. Heating Equipment: Provide a permanent heating system, with individual space thermostatic control:
 - 1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
- F. Heating Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed.
- G. Electrical Outlets: Properly configured, NEMA-polarized outlets that will prevent insertion of 110v or 120v plugs into higher-voltage outlets, and equipped with ground-fault circuit interrupters with reset button.
- H. Power Distribution System Circuits: Where permitted, overhead, and visible wiring circuits, not exceeding 125-V ac, 20-A rating, and lighting circuits may be nonmetallic-sheathed cable.

- I. Electrical Power Cords: Provide grounded extension cords; use hard-service as defined by NFPA 70, Article 400, where exposed to abrasion and traffic. If single lengths of extension cords will not reach areas where construction activities are in progress provide waterproof connectors to connect separate lengths of electrical extension cords.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Submit all temporary structures and temporary utility service for review and approval by the Building Code authority.
- B. Prior to installation of temporary facilities and utilities, submit to the COR a site layout providing locations and details of the facilities and utilities.
- C. Use qualified personnel for installation of temporary facilities. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Plan for the relocation and modification of facilities as work progresses.
- D. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 CONTRACTOR STAGING AREA - GENERAL

- A. The Contractor will be allowed to store and stage his materials in a staging area located on GPO property as indicated or as designated by the COR for such purposes. Space is limited to area indicated. The Contractor is to document the condition of the staging area prior to occupancy with photographs, video-recording and an inspection report.
- B. Protect all stored equipment from the weather. The GPO accepts no responsibility for items stored in this area.
- C. Upon completion of Construction, remove all temporary staging area facilities and return the areas to their original condition.
- D. Park construction equipment in the storage site or approved locations on the Jobsite when equipment is not engaged in construction activity.
- E. Do not stockpile construction materials, spoils, debris or refuse in any area other than that specifically approved for such purpose.
- F. Constrain stockpiled material in a manner to prevent its movement by wind, jet blast, propeller wash or run-off from rain
- G. Maintenance Requirements for Staging Areas:
 1. Unauthorized soil and concrete stockpiles are prohibited.

2. Cover all containers and drums of any size that are stored on site and their required secondary containment to prevent rainwater from coming in contact with the containers. Earthen berms are not permitted. Clearly label all drums and containers used to hold trash and debris "Trash". Empty drums and containers when full. Remove all unused empty drums and containers from the site.
3. Include the staging area in the SPPP.
4. Store all fuel, petroleum-based products and products potentially detrimental to the environment in aboveground tanks.
5. Aboveground storage tanks:
 - a. Double walled and approved for the use intended.
 - b. Submit manufacturer's literature for approval in writing for each storage tank.
6. Store all trash, construction debris, and other debris in metal containers specifically designed for such use. Do not keep trash containers on the site for more than 45 calendar days.
7. Storage of used tires and batteries is prohibited.
8. Storage of waste oil is prohibited.
9. Only routine light equipment maintenance shall be permitted. Should the Contractor require more than routine maintenance to be performed on site, submit a Construction Equipment Maintenance work for written approval, describing the type of maintenance and the procedures that will be implemented to protect the environment.

3.3 TEMPORARY UTILITY INSTALLATION

- A. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment from that specified that would not have a harmful effect on completed installations or elements being installed.
 1. Maintain a minimum temperature of 50 deg F in permanently enclosed portions of building for normal construction activities, and 65 deg F for finishing activities and areas where finished Work has been installed.
- B. Ventilation and Humidity Control: Provide temporary ventilation and humidity control required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that would not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption. Provide and operate either exhaust or supply fans/blowers, or both, sufficient to ventilate work areas adequately.
- C. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations and traffic conditions.
 1. Provide and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 2. Provide exterior-yard site lighting that will provide adequate illumination for construction operations, traffic conditions, and signage visibility when the Work is being performed. Provide exterior yard and site lighting aligned so as not to interfere with ground, air traffic and air traffic control.

3. Install lighting for Project identification signs.

D. Telephone Service: Provide temporary telephone service for key personnel engaged in construction activities, throughout the construction period. Install telephones on separate lines for each temporary office and first aid station. Where an office that has more than two occupants, install a telephone for each additional occupant or pair of occupants.

1. At each construction office and at the Jobsite post the current emergency contact list for the Program.
2. Provide portable cellular telephones for the Key Personnel for the Program and each Task Order to use in making and receiving telephone calls when away from the Jobsite.

3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Prepare and submit a Site Layout plan. Prepare and submit updates of the Site Layout plan as work progresses.
2. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet of building lines. Comply with NFPA 241.

B. Dewatering Facilities and Drains: Comply with requirements in the Construction Documents, applicable government regulations, and industry standards for temporary drainage and dewatering facilities and operations. Maintain the Jobsite, excavations, and construction to be free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining property nor endanger permanent Work or temporary facilities.
2. Before connection and operation of permanent drainage piping system, provide temporary drainage where roofing or similar waterproof deck construction is completed.
3. Remove snow and ice as required to minimize accumulations.

C. Identification and Temporary Signs: Prepare and submit for approval Program and Task Order identification signs and sign supports for installation when required by the Construction Documents. Provide two identification signs for each Construction Work Package. Provide and install construction entrance area signs to direct deliveries, construction personnel and visitors to the Jobsite entrance point. Submit for approval the proposed installation of any temporary, Contractor company "logo" signs. Two Contractor "logo" signs may be installed with approval of the COR:

1. Engage an experienced sign painter to apply graphics for Project identification signs. Comply with details indicated.
2. Prepare temporary signs to provide directional information to construction personnel and visitors.
3. Construct signs of exterior-type, Grade B-B, high-density concrete form overlay plywood in sizes and thickness indicated. Support on nominal 4-inch-by-4-inch-by-10-foot-long posts or framing of preservative-treated wood or steel.
4. Paint sign panel and applied graphics with exterior-grade alkyd gloss enamel over exterior primer.
5. The following signs will be allowed on the Project:

- a. Identifying captions over offices.
 - b. Other signs as required by the Construction Documents.
- D. Take necessary steps to prevent installation of unauthorized signs and, should any appear, remove them immediately. Repair and repaint damage caused thereby at no additional cost to the GPO.
- E. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Containerize and clearly label hazardous, dangerous, or unsanitary waste materials separately from other waste. Comply with Division 01 Section "Execution" for progress cleaning requirements.
 1. If required by COR, provide separate containers, clearly labeled, for each type of waste material to be deposited.
 2. Develop a waste management plan for the Work. Indicate types of waste materials that will be produced and estimate quantities of each type. Provide detailed information for on-site waste storage and separation of recyclable materials. Provide information on destination of each type of waste material and means to be used to dispose of all waste materials.
- F. Janitorial Services: Provide janitorial services on a daily basis for temporary offices, first-aid stations, toilets, wash facilities, lunchrooms, and similar areas.
- G. COR's Field Office (Option):
 1. Provide, furnish and maintain a temporary field office facility for exclusive use of the GPO's construction administration staff. The field office is to be a weatherproof modular building or buildings, delivered and installed at the location approved by the COR. The GPO field office shall be independent of any buildings used by the Contractor. The GPO field office that is provided shall remain on the Jobsite for the duration of the Contract or otherwise indicated. Upon completion and close-out of the Contract, the GPO field office is to be removed by the Contractor.
 2. COR's field offices shall have ceiling height of not less than 7-feet and 6-inches, and floor space of approximately 3,000 square feet. Provide the office with sufficient heat, natural and artificial light, and air conditioning. Equip doors and windows with Best locks. Suitable sanitary facilities separate from those for the Contractor's personnel, and meeting Federal, State and Local Health Department requirements shall be provided, and maintained in good working condition at all times during the period of the Contract. Detailed requirements for site work, office layout, etc. shall be coordinated with the COR. Approval of the cost for the GPO field office shall be approved by the Contracting Officer in advance of the purchase or rental of the field office and the start of any work on the field office.
 3. In addition, the following equipment and furniture, meeting COR's approval, shall be furnished:
 - a. One carbon dioxide fire extinguisher (10-lb. rated capacity).
 4. Remove field office when no longer required by COR, but not prior to 30 calendar days after completion of Punch List work.
- H. Storage and Fabrication Sheds, Structures and Work Areas: Submit as part of the Site Layout Plan the location, size, use, type of construction, and utility service details for all storage and fabrication sheds, structures and work areas. Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services.

1. Construct framing, sheathing, and siding using metal components or fire-retardant-treated lumber and plywood.
 2. Paint exposed lumber and plywood with exterior-grade acrylic-latex emulsion over exterior primer.
- I. Submit the design of storage structures of more than 150 sq. ft. to COR for review and approval by the GPO's Building Codes/Environmental Department.
- J. Tower Cranes and Mobile Cranes: Prepare and submit for review a detailed plan for tower crane installation and operation, and for all mobile crane operations.
- K. Lifts and Hoists: Submit for review lifts and hoisting equipment and personnel certified for installation and operation of the equipment. The Contractor may not use passenger elevators for transport of personnel, materials or equipment.
- L. Temporary Elevator Usage: Refer to Division 14 Sections for temporary use of new elevators.
- M. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate. Cover finished permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.
- N. Existing Stair Usage: The Contractor may only use the existing public areas, corridors and stairs where required to access construction work areas. The Contractor must clean and maintain public areas, corridors and stairs in a clean and safe condition at all times.
1. Submit photographs, video-recordings and an inspection report of existing conditions prior to use.
 2. Submit a Plan for Protecting the Existing Building Materials and Systems. Maintain means of egress, wayfinding information, lighting and other building systems. Do not create trip hazards. Provide protective coverings, barriers, devices, signs, or other procedures to protect public areas, corridor and stairs. If existing building materials or systems or damaged, submit a damage report and a proposed restoration plan. All restoration work is subject to the acceptance of the GPO.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours of 7:00 a.m. to 4:00 p.m., unless directed otherwise by the COR, which will minimize complaints from persons or firms near the Jobsite.
- B. Pest Control: Before the start of demolition, excavation or foundation work retain a local exterminator or pest-control company to inspect the site and provide a plan and schedule for treatment of the site. Implement pest control to include treatment and traps for rodents, roaches, and other pests. Engage pest-control services to perform extermination and control procedures at regular intervals so that the Jobsite, the new Work, and adjacent facilities. Obtain an extended one (1) year pest control warranty for the GPO. Perform control operations lawfully, using environmentally safe materials.

- C. Jobsite Enclosure Fence: The Jobsite must be secured to prevent unauthorized entry. Prepare and submit with the Site Layout Plan the plan and details for securing the Jobsite. Enclosure fence is to be used with posts set in the ground to prevent being blown over by the wind. Provide entrance gates which are to be secured when the Jobsite is not occupied. Before construction operations begin, provide portable chain-link site enclosure fence. Minimum 2-inch, 9-gage, galvanized steel, chain-link fabric fencing; minimum 8 feet high with galvanized steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch-OD corner and pull posts, with 1-5/8-inch-OD top and bottom rails.
1. Entrance into the site: Only through the lockable entrance gates.
 2. Provide gates in sizes and at locations necessary to accommodate delivery vehicles and other construction operations.
 3. Maintain security by limiting number of keys and restricting distribution to authorized personnel.
- D. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.
- E. Barricades, Warning Signs, and Lights: Comply with standards and code requirements for erecting structurally adequate barricades. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of possible hazard. Where appropriate and needed, provide lighting, including flashing red or amber lights. See the GPO's Construction Safety Manual for additional requirements.
- F. Temporary Covered Walkway Structures: Prepare and submit plans, details and calculations stamped by a Professional Engineer licensed in Virginia for temporary covered walkway structures. Review and approval of the Building Code GPO is required. Install and construct temporary walkway structures for passage of persons along adjacent public streets and pedestrian walkways. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.
- G. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Prepare and submit plans, details and calculation stamped by a Professional Engineer licensed in Virginia for temporary enclosure structures. Review and approval of the Building Code GPO is required. Provide temporary enclosure structures for openings in new and existing facilities, where shown or required for security, protection from the weather, protection of new or existing work, and similar requirements. The public sides of all temporary enclosure structures are to be painted. Provide temporary weather tight enclosure for building exterior.
1. Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.
 2. Vertical Openings: Close openings of 25 sq. ft. or less with plywood or similar materials.
 3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.
 4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.
 5. Use fire-retardant-treated wood and plywood for temporary enclosures. Use fire-retardant-treated material for framing and main sheathing.
- H. Temporary Partitions: Erect and maintain dustproof partitions and temporary enclosures to limit

dust and dirt migration and to separate areas from fumes and noise. Prepare and submit plans, details and calculations stamped by a Professional Engineer licensed in Virginia for temporary interior wall partitions. Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise. The public sides of all temporary interior wall partitions are to have joints taped and sanded, and the partition painted. Temporary interior wall partitions are to span from the top of floor to the underside of the overhead deck. Insulate partitions to provide noise protection for the public and occupied spaces.

1. Construct dustproof partitions of not less than nominal 4-inch studs, 5/8-inch gypsum wallboard with joints taped on occupied side, and 1/2-inch fire-retardant plywood on construction side. Provide protective wall covering as required. Paint all gypsum board surfaces.
2. Construct dustproof, floor-to-ceiling partitions of not less than nominal 4-inch studs, 2 layers of 3-mil polyethylene sheets, inside and outside temporary enclosure. Cover floor with 2 layers of 3-mil polyethylene sheets, extending sheets 18 inches up the side walls. Overlap and tape full length of joints. Cover floor with 3/4-inch fire-retardant plywood.
 - a. Construct a vestibule and airlock at each entrance to temporary enclosure with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
3. Insulate partitions to provide noise protection to occupied areas.
4. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
5. Protect air-handling equipment.
6. Weather-strip openings.
7. Paint face of visible partitions a color acceptable to the GPO, and provide partitions with an applied base material likewise acceptable to the GPO. Finish walls with protective wall covering wainscot, bumper guards, and corner guards as specified below.
8. Provide 40 inches of protective wall treatment from floor for temporary partitions with exposed faces located in public spaces.
9. Protective wall treatment:
 - a. Protective Wall Covering: Minimum 0.060 inches thick; with trim shapes and formed corners in same color as wall covering, as required for complete installation.
 - 1) Product and Manufacturer: "Acrovyn Fiber-Backed Wall Covering" by Construction Specialties, Inc., or as approved by the GPO. Surface texture "Pebbelette," with color as selected by COR from manufacturer's full standard color range.
 - 2) Fire-Resistance Ratings: Classified by UL according to ASTM E 84, with flame spread of 25 or less and smoke developed of 50 or less.
 - 3) Adhesive: Mildew- and fungus-resistant, non-staining, removable type as recommended by wall covering manufacturer. Adhesive shall permit future removal of wall covering without damaging substrate.
 - 4) Primer and Sealer: As recommended by wall covering manufacturer for each type of substrate.
 - b. Bumper Guards: Surface-mounted bumper guards, 4 inches high by approximately 13/16 inches deep; color, same color as wall covering. Provide bumper guards as a system of integral-colored vinyl/acrylic sheets with manufacturer's standard formed inside and outside corner trim, connectors concealed mounting brackets, and end caps.

- 1) Product and Manufacturer: "Acrovyn Series SCR-40" by Construction Specialties, Inc., or as approved by the GPO.
- c. Corner Guards: Surface-mounted corner guards, 3 inches by 3 inches by 40 inches high with 90-degree bend; color, same color as wall covering; consisting of abrasion-resistant, colored polycarbonate sheet, UV-stabilized against yellowing; complying with the following performance criteria:
 - 1) Impact resistance: 16 lb./inch of notch, when tested according to ASTM D 256.
 - 2) Yellowing Index: Less than 2.0 after 3 years' exposure, when tested according to ASTM D 1925.
 - 3) Product and Manufacturer: "Acrovyn Series SM-20" by Construction Specialties, Inc., or as approved by the GPO.
- I. Adhesive: Clear, non-staining, non-yellowing, as recommended by corner guard manufacturer for mounting corner guards to gypsum board.
- J. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
 1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.
 - a. Field Offices: Class A, stored-pressure, water-type extinguishers.
 - b. Other Locations: Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.
 - c. Locate fire extinguishers per NFPA 10 and where convenient and effective for their intended purpose; provide not less than one extinguisher on each floor at or near each usable stairwell.
 2. Store combustible materials in containers in fire-safe locations.
 3. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for firefighting. Prohibit smoking in hazardous fire-exposure areas.
 4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition.
 5. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.
 6. Develop and supervise an overall fire-prevention and first-aid fire-protection program for personnel at the Jobsite. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 7. Provide temporary standpipes with fire hose valve connections for fire protection.
- K. Storage: Where materials and equipment are stored, and are of value or attractive for theft, provide secure lockup. Enforce discipline in connection with installation and release of material to minimize opportunity for theft and vandalism.

END OF SECTION 01 50 00

SECTION 01 60 00 - PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following administrative and procedural requirements: selection of products for use; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.
 - 1. This Section includes substitutions made for "or as approved by the GPO" items.
- B. Related Sections include the following:
 - 1. Division 01 Section "References" for applicable industry standards for products specified.
 - 2. Construction Documents for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

- A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent:
 - 1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of date of the Construction Documents.
 - 2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.
 - 3. Comparable Product: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Construction Documents and proposed by the Contractor.
- C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of

evaluating comparable products of other named manufacturers.

1.4 SUBMITTALS

- A. Product List: Submit a list, in tabular form acceptable to the COR, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product:
1. Coordinate product list with the Contractor's CPM Schedule and Submittals Schedule.
 2. Form: Tabulate information for each product under the following column headings:
 - a. Task Order Name and Number.
 - b. Specification Section number and title.
 - c. Generic name used in the Construction Documents.
 - d. Proprietary name, model number, and similar designations.
 - e. Manufacturer's name and address.
 - f. Supplier's name and address.
 - g. Installer's name and address.
 - h. Projected delivery date or time span of delivery period.
 - i. Identification of items that require early submittal approval for scheduled delivery date.
 - j. Item Tag Number or similar ID if identified in the drawings.
 - k. Location (room number from the drawings)
 - l. Serial Number (once available)
 3. Initial Submittal: Within sixty (60) calendar days after the Notice to Proceed for the Task Order, submit the initial product list. Include a written explanation for omissions of data and for variations from the Contract Documents.
 4. COR's Action: The COR will respond in writing to the Contractor within a minimum of 15 calendar days of receipt of initial product list. The COR's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. The COR's response, or lack of response, does not constitute a waiver of the requirement that products comply with the Contract Documents.
 5. Updated submittal: Submit updated product list every 90 days following initial submittal. The updated list shall be submitted in approved electronic spread sheet format with additional fields as required by the COR.
 6. Completed List: Submit an electronic copy of the completed product list 90 calendar days before requesting inspection for Substantial Completion. Include a written explanation for omissions of data and for variations from the Contract Documents.
- B. Substitution Requests: Submit an electronic copy of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Section number and title and Drawing numbers and titles:
1. Substitution Request Form: Submit requests in the form and according to procedures required for Contract Modification proposals supplied to the Contractor at the preconstruction meeting or as directed by COR and at no additional cost to the contract. Do not submit requests for substitutions as "Requests for Information" (RFIs).
 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

- a. Statement indicating why specified material or product cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the GPO and other contractors that will be necessary to accommodate proposed substitution.
 - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. List of similar installations for completed projects with names and addresses of architects and owners.
 - g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - h. Research/evaluation reports evidencing compliance with building code in effect from a model code organization acceptable to authorities having jurisdiction.
 - i. Detailed comparison of the Contractor's CPM Schedule using the proposed substitution with products specified for the Work, including the effect on the critical path activities and the Time of Performance for the Construction Work Package. If the specified product or method of construction cannot be provided within the Time of Performance, include a letter from the manufacturer, on the manufacturer's letterhead, stating lack of availability or delays in delivery.
 - j. Cost information, including a proposal of change, if any, in the Task Order Price.
 - k. The Contractor's certification that proposed substitution complies with requirements in the Construction Documents and is appropriate for applications indicated.
 - l. The Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
 - m. Failure by the Contractor to include the above requirements in the submittal may cause rejection of the submittal in its entirety.
3. COR's Action: If necessary, the COR will request additional information or documentation for evaluation within a minimum of 15 calendar days of receipt of a request for substitution. The COR will notify the Contractor of acceptance or rejection of the proposed substitution within a minimum of 15 calendar days of receipt of request, or two weeks of receipt of additional information or documentation, whichever is later:
 - a. Form of Acceptance: Change order issued by the Contracting Officer.
 - b. Use product specified if the COR couldn't make a decision on use of a proposed substitution within time allocated.
- C. Comparable Product Requests: Submit an electronic copy of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles:
 1. COR's Action: If necessary, the COR will request additional information or documentation for evaluation within a minimum of 7 working days of receipt of a comparable product request. The COR will notify the Contractor of approval or rejection of proposed comparable product request within a minimum of 15 calendar days of receipt of request, or within a minimum of 7 calendar days of receipt of additional information or documentation, whichever is later:

- a. Form of Approval: As specified in Division 01 Section "Submittals."
 - b. Use product specified if the COR couldn't make a decision on use of a comparable product request within time allocated.
- D. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittals." Show compliance with requirements.

1.5 QUALITY ASSURANCE

- A. Compatibility of Options: If the Contractor is given option of selecting between two or more products for use, the product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions. B. Delivery and Handling:
 - 1. Schedule delivery to minimize long-term storage at the Jobsite and to prevent overcrowding of construction spaces.
 - 2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 - 3. Deliver products to the Jobsite in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 - 4. Inspect products on delivery to ensure compliance with the Construction Documents and to ensure that products are undamaged and properly protected.
- B. Storage:
 - 1. Store products to allow for inspection and measurement of quantity or counting of units.
 - 2. Store materials in a manner that will not endanger the Jobsite or adjacent facilities and operations.
 - 3. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
 - 4. Comply with product manufacturers written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
 - 5. Store foam plastic away from exposure to sunlight, except to extent necessary for period of installation and concealment.
 - 6. Store cementitious products and materials on elevated platforms.
 - 7. Protect stored products from damage.
 - 8. Replace products and materials damaged by the elements due to improper storage at no additional cost to the GPO. This damage can be, but not limited to, oxidization, mold, mildew, warping, and rust.

1.7 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of obligations under requirements of the Contract Documents:
 - 1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to the GPO.
 - 2. Special Warranty: Written warranty required by or incorporated into the Construction Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for the GPO.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution:
 - 1. Manufacturer's Standard Form: Modified to include Program and Task Order specific information and properly executed.
 - 2. Specified Form: When specified forms are included with the Construction Documents, prepare a written document using appropriate form properly executed.
 - 3. Refer to the Construction Documents for specific content requirements and particular requirements for submitting special warranties.
- C. Submittal Time: Comply with requirements in Division 01 Section "Project Closeout."

PART 2 PRODUCTS

2.1 PRODUCT OPTIONS

- A. General Product Requirements: Provide products that comply with the Construction Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation:
 - 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
 - 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. The GPO reserves the right to limit selection to products with warranties not in conflict with requirements of the Construction Documents.
 - 4. Where products are accompanied by the term "as selected," the COR will make the selection.
 - 5. Where products are accompanied by the term "match sample," sample to be matched is the COR's.
 - 6. Descriptive, performance, and reference standard requirements in the Construction Documents establish "salient characteristics" of products.
 - 7. "Or as approved by the GPO": Note that products submitted under an "or as approved by the GPO" provision are considered to be substitutions.
- B. Product Selection Procedures:
 - 1. Product: Where the Construction Documents name a single product and manufacturer,

- provide the named product that complies with requirements.
2. Manufacturer/Source: Where Construction Documents name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.
 3. Products: Where the Construction Documents include a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
 4. Manufacturers: Where the Construction Documents include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
 5. Available Products: Where the Construction Documents include a list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part - 2 "Comparable Products" Article for consideration of an unnamed product.
 6. Available Manufacturers: Where the Construction Documents include a list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part - 2 "Comparable Products" Article for consideration of an unnamed product.
 7. Product Options: Where the Construction Documents indicate that sizes, profiles, and dimensional requirements are based on a specific product or system, provide the specified product or system. Comply with provisions in Part 2 "Product Substitutions" Article for consideration of an unnamed product or system.
 8. Basis-of-Design Product: Where the Construction Documents name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Construction Documents indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in Part 2 "Comparable Products" Article for consideration of an unnamed product by the other named manufacturers.
 9. Visual Matching Specification: Where the Construction Documents require matching an established Sample, select a product that complies with requirements and matches the COR's sample. The COR's decision will be final on whether a proposed product matches.
 10. If a product is not available within the specified category that matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for the proposal of product.
 11. Visual Selection Specification: Where the Construction Documents include the phrase "as selected from manufacturer's colors, patterns, and textures" or a similar phrase, select a product that complies with other specified requirements:
 - a. Standard Range: Where the Construction Documents include the phrase "standard range of colors, patterns, textures" or similar phrase, the COR will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
 - b. Full Range: Where the Construction Documents include the phrase "full range of colors, patterns, textures" or similar phrase, the COR will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 PRODUCT SUBSTITUTIONS

- A. Timing: The COR will consider requests for substitution if received within 60 calendar days after issuance of the Notice to Proceed for a Task Order. Requests received after that time may be considered or rejected at the sole discretion of the Contracting Officer.

- B. Conditions: The COR will consider the Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the COR will return requests without action, except to record noncompliance with these requirements:
1. Requested substitution does not require extensive revisions to the Construction Documents.
 2. Requested substitution is consistent with the Construction Documents and will produce indicated results.
 3. Substitution request is fully documented and properly submitted.
 4. Requested substitution will not adversely affect the Contractor's CPM Schedule.
 5. Requested substitution has received necessary approvals of authorities having jurisdiction.
 6. Requested substitution is compatible with other portions of the Work.
 7. Requested substitution has been coordinated with other portions of the Work.
 8. Requested substitution provides specified warranty.
 9. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- C. The Contractor's submittal and the COR's review or approval of Shop Drawings, Product Data, or Samples that relate to a substitute does not by itself constitute a final approval of the requested substitution, nor does it relieve the Contractor from fulfilling the requirements of the Contract Documents.
- D. If a substitution offers a substantial advantage to the GPO, in terms of cost, time, energy conservation, or other considerations of merit, after deducting offsetting responsibilities of the GPO, the substitution shall be submitted as a Value Engineering Change Proposal.

2.3 COMPARABLE PRODUCTS

- A. Conditions: The COR will consider the Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, the COR will return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require extensive revisions to the Construction Documents, it is consistent with the Construction Documents, it will produce the indicated results, and that it is compatible with other portions of the Work.
 2. Detailed comparison of significant qualities of proposed product with those named in the Construction Documents. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 3. Evidence that proposed product manufacturer and installer provide the specified warranty.
 4. List of similar installations for completed projects with names and addresses of architects and owners, if requested.
 5. Samples, if requested.

PART 3 EXECUTION (Not Used)

END OF SECTION 01 60 00

SECTION 01 73 00 - EXECUTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. Construction layout.
 - 2. Field engineering and surveying.
 - 3. General installation of products.
 - 4. Coordination of GPO-installed products.
 - 5. Progress cleaning.
 - 6. Starting and adjusting.
 - 7. Protection of installed construction.
 - 8. Correction of the Work.
- B. Related Sections include the following:
 - 1. Division 01 Section "Project Management and Coordination" for procedures for coordinating field engineering with other construction activities.

1.3 SUBMITTALS

- A. Qualification Data: Submit DC License and qualification data for land surveyors and professional engineers.
- B. Certificates: Submit certificate signed and sealed by a land surveyor or a professional engineer certifying that location and elevation of improvements comply with requirements.
- C. Certified Surveys: Submit two (2) copies signed and sealed by a licensed professional land surveyor.
- D. Project Record Documents: Submit a record of Work performed (materials tests, inspections, acceptance tests, etc.) and record survey data as required under provisions in Division 01 Sections "Submittals" and "Project Closeout."

1.4 QUALITY ASSURANCE

- A. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the DC experienced in the area for which he is utilized.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work, including all site utility systems:
 - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: Information provided by the GPO regarding the existence and location of utilities and construction indicated as existing is not exact and must be verified by the Contractor. Before beginning site work, investigate and verify the existence and location of utilities and other existing conditions affecting the Work:
 - 1. Before construction, verify the location at points of connection of sanitary sewer, storm sewer, and water-service piping; and electrical and communication services.
- C. Acceptance of Conditions: Examine areas, and conditions, with the Superintendent, Foremen and Subcontractors present, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations:
 - 1. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
 - a. Description of the Work:
 - 1) List of detrimental conditions.
 - 2) List of unacceptable installation tolerances.
 - 3) Recommended corrections.
 - 2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
 - 4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Existing Utility Information: Furnish information to the COR that is necessary to adjust, move, or relocate existing utility structures, lines, services, or other utility appurtenances located in or affected by construction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to

other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on the Construction Documents.
- D. Review of Construction Documents and Field Conditions: Immediately on discovery of the need for clarification of the Construction Documents, submit a request for information (RFI) to the COR. Include a detailed description of problem encountered, together with recommendations for changing the Construction Documents.

3.3 CONSTRUCTION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on the Construction Documents, in relation to existing conditions. If discrepancies are discovered, notify the COR promptly.
- B. General: Engage a Registered Surveyor to layout the Work using accepted surveying practices.
 - 1. Establish Benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of the Work.
 - 2. Establish dimensions within tolerances indicated. Do not scale drawings to obtain required dimensions.
 - 3. Inform installers of lines and levels to which they must comply.
 - 4. Check the location, level and plumb, of every Definable Feature and Element of Work as the work progresses.
 - 5. Notify the COR when deviations from required lines and levels exceed allowable tolerances.
- C. Building Lines and Levels: Locate and lay out control lines and levels for structures, column grids, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels.
- D. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the COR.

3.4 FIELD ENGINEERING

- A. Identification: Existing Horizontal Control points are as identified on the Construction Documents.
- B. Reference Points: Locate control points, and similar reference points before beginning the Work. Preserve and protect control points during construction operations.
 - 1. Do not change or relocate control points without prior written approval of the COR.

3.5 INSTALLATION

- A. Inspection of Conditions: Require the installer of each major component to inspect both the substrate and conditions under which Work is to be performed. Proceed only after unsatisfactory conditions have been corrected in a manner acceptable to the COR. Coordinate this requirement with Division 01 Section "Quality Requirements."
- B. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
 - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
 - 4. Maintain minimum headroom clearance in spaces as indicated in the Construction Documents.
 - 5. Roughing-in of utilities in areas with vaulted or domed roofs shall follow contour of roof lines.
- C. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- D. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- E. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- F. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, prepare and submit an RFI.
 - 2. Allow for building movement, including thermal expansion and contraction.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, prepare and submit an RFI. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 GPO-INSTALLED PRODUCTS

- A. Site Access: Provide access to the Jobsite for the GPO's forces.
- B. Coordination: Coordinate construction and operations of the Work with work performed by the GPO's forces.
 - 1. Construction Schedule: Coordinate the Contractor's preferred construction schedule for the GPO's portion of the Work, if any, with the COR. Adjust the construction schedule

based on a mutually agreeable timetable. Notify the COR in writing if changes to the schedule are required due to differences in actual construction progress.

2. Pre-installation Conferences: Include the GPO's forces at pre-installation conferences covering portions of the Work that are to receive the GPO's work. Attend pre-installation conferences conducted by the GPO's forces if portions of the Work depend on the GPO's construction.

3.7 PROGRESS CLEANING

- A. General: Clean the Jobsite and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
 2. Remove combustible debris from the site daily.
 3. Do not hold materials more than seven (7) days during normal weather or three (3) days if the temperature is expected to rise above 80 deg F.
 4. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain the Jobsite free of waste materials and debris.
 1. Remove liquid spills promptly.
 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- C. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- D. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- E. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- F. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.
 1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.
- G. Waste Disposal: All waste materials must be removed from the Jobsite and the airport, and disposed in accordance with all applicable government regulations. Burying or burning waste materials on-airport property will not be permitted. Washing waste materials down sewers or into waterways is not be permitted.
- H. During handling and installation, clean and protect construction in progress and adjoining

materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.8 STARTING AND ADJUSTING

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

3.9 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure that installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
- B. Comply with requirements in Division 01 Section "Cutting and Patching."
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

- E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 01 73 00

SECTION 01 73 29 - CUTTING AND PATCHING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes procedural requirements for cutting and patching.
- B. Related Sections include the following:
 - 1. Division 07 Section "Penetration Fire stopping" for patching fire-rated construction.
 - 2. Divisions 03 through 28 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

- A. Cutting and Patching Proposal: Submit a proposal, requesting approval from the COR to proceed, describing procedures at least ten (10) days before the time cutting and patching will be performed. Include the following information:
 - 1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
 - 2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
 - 3. Products: List products to be used and firms or entities that will perform the Work.
 - 4. Dates: Indicate when cutting and patching will be performed.
 - 5. Utility Services and Mechanical/Electrical Systems: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted. Before cutting/core drilling the slab, structural members, concrete walls, etc. X-ray the slab, beam, wall, etc. to determine whether any embedded items such as conduit and reinforcing steel would be cut or disturbed and provide X-rays to COR. If the cutting/core drilling will cut any conduits, notify the COR to re-locate the opening or take other action as required. If reinforcing steel

is encountered, notify the COR to either re-locate the opening or evaluate the effect of cutting the reinforcement. Perform this evaluation by a registered professional engineer licensed in the Commonwealth of Virginia. Refer to Division 01 Section "Summary" for utility outage requirements.

6. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure. When cutting and patching involves welding or open flame cutting, obtain the approval of the GPO's Fire Marshal for such work prior to its start. Before cutting or drilling a structural element, X-ray the element to determine whether any embedded items such as conduit and reinforcing steel would be cut or disturbed and submit the X-ray report. Do not cut or core drill any holes through rebar, conduits or other embedded items. Prepare and submit an RFI when conflicts exist. Provide the services of a professional engineer licensed in Virginia to evaluate and provide details for modification of existing systems and structures.
7. COR's Approval: Obtain the COR's approval in writing of cutting and patching proposal before cutting and patching. Approval does not waive the GPO's right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio. Submit a plan for cutting and patching of structural elements.
- B. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety. Submit a plan for cutting and patching for the following types of systems and equipment:
 1. Primary operational systems and equipment.
 2. Air or smoke barriers.
 3. Fire-suppression systems.
 4. Control systems.
 5. Communication systems.
 6. Conveying systems.
 7. Electrical wiring systems.
 8. Special systems.
 9. Security systems including CCTV and duress alarms.
 10. Other operating systems as identified in the Construction Documents.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that results in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety. Submit a plan for cutting and patching the following types of miscellaneous elements:
 1. Water, moisture, or vapor barriers.
 2. Membranes and flashings.
 3. Exterior curtain-wall construction.
 4. Equipment supports.
 5. Piping, ductwork, vessels, and equipment.
 6. Noise- and vibration-control elements and systems.

7. Insulating systems.
8. Other miscellaneous elements indicated in the Construction Documents.

- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that reduces the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1. Processed concrete finishes.
2. Stonework and stone masonry.
3. Ornamental metal.
4. Matched-veneer woodwork.
5. Preformed metal panels.
6. Roofing.
7. Fire stopping.
8. Window wall system.
9. Stucco and ornamental plaster.
10. Terrazzo.
11. Finished wood flooring.
12. Fluid-applied flooring.
13. Aggregate wall coating.
14. Wall covering.
15. HVAC enclosures, cabinets, or covers.
16. Other types of exposed construction indicated on the Construction Documents.

- E. Cutting and Patching Conference: Before proceeding, meet at the Jobsite with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 MATERIALS

- A. General: Comply with requirements specified in the Construction Documents and the other Divisions 1 Specification Sections.
- B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible:
1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed:
 - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect existing construction and facilities during cutting and patching to prevent damage. Provide protection from adverse weather conditions for adjacent facilities and portions of the Work that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned; bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay:
 - 1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations:
 - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
 - 2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
 - 3. For concrete and masonry, cut using a cutting machine, such as an abrasive saw or a diamond-core drill.

4. Excavating and Backfilling: Should excavating and backfilling be required by cutting and patching operations comply with requirements in applicable sections of the Construction Documents.
 5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting. Remove conductors back to source of supply.
 6. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in the Construction Documents and other Division 1 Specification Sections:
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
 2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
 3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance:
 - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.
 4. Ceilings: Patch, repair, or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
 5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

END OF SECTION 01 73 29

SECTION 01 77 00 - PROJECT CLOSEOUT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Task Order closeout, including, but not limited to, the following:
 - 1. Substantial Completion requirements.
 - 2. Final Completion and Acceptance.
 - 3. Warranties.
 - 4. Final cleaning and Pest Control.
- B. Related Sections include the following:
 - 1. Division 01 Section "Quality Requirements" for final requirements of the Warranty Manual.
 - 2. Division 01 Section "Photographic Documentation" for submitting Final Acceptance construction photographs and negatives.
 - 3. Division 01 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, Record Product Data, and other Record Documents.
 - 4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
 - 5. Technical Specification Sections for specific closeout and special cleaning requirements for products of those Sections.

1.3 SUBSTANTIAL COMPLETION

- A. Definition: "Substantial Completion" is defined in the Contract.
- B. Requirements for Substantial Completion in addition to those set forth in the Contract:
 - 1. Certificate of Occupancy or Temporary Certificate of Occupancy: a Certificate of Occupancy or Temporary Certificate of Occupancy has been obtained by the Contractor from the GPO's Building Codes Department in accordance with the GPO Building Codes Manual and has been submitted.
 - 2. Quality Requirements: completion of all specified inspections and testing, submittal of all specified documentation, and receipt of the letter of certification from the Contractor's Quality Control Manager to the Contracting Officer that all Work required by the Task Order has been completed, inspected and is in full compliance with the Contract Documents, with exception of the remaining Punch List items and specified post-occupancy inspections and testing.
 - 3. Systems start-up and commissioning: completion of systems start-up and commissioning and submittal of all specified documentation, with exception of specified post-occupancy testing and adjustments.

4. Punch List: submittal of a complete and up-to-date Punch List in the approved format.
5. Submittal Log: submittal of an up-to-date submittal log showing all approved and acknowledged submittals, and with all incomplete submittals identified.
6. Warranties: submittal of a complete set of the specified warranties complete with signatures, and the date of Substantial Completion set as the start of the warranty period.
7. Operation and Maintenance Manuals: submittal of a complete set of the specified manuals.
8. Operation and Maintenance Training: completion of the specified training.
9. Final cleaning: completion of the final cleaning of the Work and submittal of documentation in the form of an approved walk-through inspection with the COR.
10. Photographic and Video Recordings: submittal of documentation of the conditions of the Work and the adjacent facilities as of the date of Substantial Completion.
11. Deliverables for turnover: completion and submittal of documentation that all deliverables, such as, keys, spare parts and specialty tools, have been turned over and accepted by the GPO.
12. Changeover to Permanent Locks: completion and submittal of documentation of all required changeover to permanent locks.
13. Meter Readings: submittal of documentation for all meter readings as of the date of Substantial Completion.
14. Insurance: submittal of documentation of notifications for changeover of insurance coverages and certificates.

C. Procedures

1. Advance notification: Submit a written notice to the Contracting Office and the COR a minimum of three weeks prior to the Scheduled Substantial Completion Date to include the status of the Work and all of the requirements.
2. Request for Inspection: Submit a written request for inspection to the Contracting Officer and the COR a minimum of one week prior to when the Contractor believes Substantial Completion will be achieved, to include the status of the Work and all of the requirements. Upon receipt of the request, the COR will either proceed with inspection or notify the Contractor of unfulfilled requirements. After the inspection, the COR will notify the Contractor of items, either on the Contractor's list or additional items identified by the COR, that must be completed or corrected before a Certificate of Substantial Completion will be issued.
3. Request for Re-Inspection: When work identified in previous inspections as incomplete is completed or corrected, submit a written request for re-inspection to the Contracting Officer and the COR. After the re-inspection, the COR will notify the Contractor of items, either on the Contractor's list or additional items identified by COR, that must be completed or corrected before certificate will be issued. Repeat this process until all items required for Substantial Completion are completed.
4. Certificate of Substantial Completion: Upon achievement of Substantial Completion, the Contracting Officer will issue a Certificate of Substantial Completion for the Work, or a designated portion thereof.

1.4 FINAL COMPLETION AND ACCEPTANCE

- A. Definition: "Final Completion" is defined in the Contract.
- B. Documentation for Final Completion and Acceptance: The Contractor must complete and submit the following as a condition of Final Completion, and before requesting the Final Completion and Acceptance Inspection:
 1. Final Building Code Inspection: Obtain approval for such inspection from the GPO's

- Building Codes Department in accordance with the GPO Building Codes Manual and submit evidence of such approval.
2. Certificate of Occupancy: Obtain such certificate from the GPO's Building Codes Department in accordance with the GPO Building Codes Manual, and submit it.
 3. Final Application for Payment: Submit the draft final Application for Payment according to Specification 012900 "Application for Payment."
 4. Subcontractor Payment Form, LDBE Exhibit J: Submit the final Subcontractor Payment Form and LDBE Participation Report, Exhibit J.
 5. Waivers of Mechanic's Liens and Claims: Submit final waivers and releases of liens and claims, on forms acceptable to the Contracting Officer, signed by the Contractor and all Subcontractors, Sub-Subcontractors and Suppliers.
 6. Record As-Built CPM Schedule: Submit documentation verifying that the Record As Built CPM Schedule has been submitted and accepted.
 7. Photographic and Video Recordings: Submit documentation that the required photographs and video recordings for Final Completion have been submitted and acknowledged.
 8. Certified Copy of the Submittal Log: Submit a copy of the Submittal Log with certification that all submittals have been provided and either accepted or acknowledged.
 9. Quality Control Certification: Furnish a certification letter to the Contracting Officer signed by the Contractor's Quality Control Manager attesting that "all Work for the Construction Work Package has been completed, inspected, tested and is in full compliance with the Contract Documents."
 10. Quality Requirements: Submit documentation verifying that all specified inspections and testing, and submittal of all specified documentation, including post-occupancy inspections and tests, have been completed and accepted.
 11. Correction of Non-Compliant Work: Submit documentation verifying that all noncompliant work has been corrected or otherwise resolved for acceptance.
 12. Certified Copy of the Punch List: Submit a copy of the Punch List with certification that all items have been completed or otherwise resolved for acceptance, endorsed and dated by the COR.
 13. Systems Start-up and Commissioning: Submit documentation verifying completion of systems start-up and commissioning, and submittal of all specified documentation, including all specified post-occupancy testing and adjustments.
 14. Warranties: submit documentation verifying that all specified warranties have been submitted and accepted.
 15. Demobilization: Submit documentation verifying that demobilization and removal of temporary facilities from the Jobsite, including equipment and materials, has been completed, and the work areas restored to an acceptable condition.
 16. GPO Issued Credentials: Submit documentation verifying that all AOA badges and other GPO issued credentials have been returned.
 17. Operation & Maintenance Manuals: Submit documentation verifying that all specified Operation & Maintenance Manuals have been submitted and accepted.
 18. Project Record Documents: Submit documentation verifying that all specified Project Record Documents have been submitted and accepted.
 19. Demonstration and Training: Submit documentation verifying that all specified Demonstration and Training has been submitted and accepted.
 20. Deliverables for turnover: Submit documentation verifying that all deliverables, such as, keys, spare parts and specialty tools, have been turned over and accepted by the GPO.
 21. Final Contract Modification: Sign and return the final Contract Modification, if applicable, to the Contracting Officer.
 22. Insurance: Submit evidence of compliance with final insurance coverage requirements.

C. Procedures.

1. Pre-Final Inspection: Submit to the Contracting Officer and the COR a written request for "Pre-Final Inspection" once all of the Work for the Construction Work Package, including

the Punch List items, has been corrected. The COR and GPO representatives will inspect the Construction Work Package to verify whether it is complete and ready for Final Inspection. GPO "Pre-Final Punch List" may be developed as a result of the inspection. Any items noted on the "Pre-Final Punch List" shall be corrected by the Contractor in a timely manner.

2. Advance Notification: Submit a written notice to the Contracting Officer and the COR a minimum of two weeks prior to the date requested for the Final Completion and Acceptance Inspection. Provide the documentation identified in subsection (B) above for Final Completion and Acceptance with the notification.
3. Final Completion and Acceptance Inspection: The date and time for the Final Completion and Acceptance Inspection will be set subject to the Contracting Officer's acceptance of the documentation for Final Completion and Acceptance. The Contracting Officer, the COR, the GPO representatives, the Project Manager, Project Manager, QCM, the superintendent, and other personnel as deemed necessary by the COR shall be in attendance for this inspection. If the Work is found not to be acceptable to the COR, the Contractor will be furnished a list of items which must be made acceptable.
4. Re-Inspection for Final Completion and Acceptance: After the Contractor completes the items identified in subsection (C)(3) above, the Contractor shall again request a Final Completion and Acceptance Inspection. If the Work inspected by the COR is then found to comply fully with the requirements of the Contract Documents, it shall be accepted by the Contracting Officer. Acceptance will not occur unless all items are acceptable. The GPO may back-charge the Contractor for additional inspection costs that are incurred for re-inspections.
5. Certificate of Final Completion and Acceptance: Upon achievement of Final Completion, the Contracting Officer will issue a Certificate of Final Completion and Acceptance.

1.5 WARRANTIES

- A. Submittal Time: Submit an electronic copy of the proposed Warranty Manual Specified below within 90 days of Notice to Proceed, for each Task Order for Construction Services. The COR will return comments to the Contractor no later than 30 calendar days after receipt.
 1. Provide Manufacturer's Standard Warranties, made out to the GPO, and statement of willingness to provide any applicable Special Warranties required by the Construction Documents 15 calendar days prior to shipping of materials and equipment. Products and Equipment shall not be considered delivered (for payment purposes) until the approved warranties have been received.
 2. The Contractor must submit a request in writing for designated portions of the Work where commencement of the warranty date other than the Substantial Completion date is requested. The COR will respond in writing within a minimum of 15 calendar days, either approving or denying the request.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by the GPO during construction period by separate agreement with the Contractor.
- C. Warranty Manual: Organize warranty documents into an orderly sequence based on the table of contents of the Technical Specifications Sections. Warranty documents include the Contractor and major Subcontractors warranty letters, special warranty documents, and manufacturer's warranties.
 1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on

spine to hold label describing contents. Binders shall not be filled beyond 75 percent of their rated capacity. Binders shall also have boomerang plastic sheet lifters, metal backbone, concealed rivet construction, and three-trigger position locking mechanism (lock, unlock, open) on top and bottom. Binder color shall be black.

- a. Provide maximum 3-inch binder thickness.
 - b. Identify each binder on front and spine, with printed title "PROJECT WARRANTIES," Contract number and name, Task Order number and name, and subject matter of contents. Indicate volume number for multiple-volume sets.
 2. Dividers: Provide three-hole, heavyweight, plastic tabbed dividers for each separate section. Provide a description of the warranty or heading on Dividers and Tabs using printer formatting. Provide an index of the contents in each section on the first page behind each section divider. The index shall be generated using a word processor and printed on a laser printer. Include a matching master table of contents for each volume using the same indexing system. Install a colored sheet between each different warranty within a tabbed section.
 3. Provide two copies of a digital version of the warranty manual on CD-ROM, and submit an electronic copy. This digital, electronic copy shall consist of a scanned Adobe® PDF file of each warranty document in the manual.
- D. Provide additional copies of each warranty that shall be included in Operation and Maintenance Manuals.

PART 2 PRODUCTS

2.1 MATERIALS

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

PART 3 EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with GPO requirements, local laws and ordinances and Federal and local environmental and antipollution regulations. General cleaning during construction is included in Division 01 Section "Execution."
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 1. Complete the following cleaning operations before requesting inspection for certification Of Substantial Completion for the Task Order or for a portion of the Task Order:
 - a. Clean the Work, the Jobsite, and adjacent facilities and grounds where disturbed by the construction activities, to include removal of rubbish, waste material, litter, dust,

- dirt, grim, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from the Jobsite.
 - e. Remove snow and ice to provide safe access.
 - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
 - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
 - h. Sweep concrete floors broom clean in unoccupied spaces.
 - i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
 - j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
 - k. Remove labels that are not permanent.
 - l. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
 - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
 - m. Wipe surfaces of mechanical and electrical equipment, [elevator equipment,] and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 - n. Replace parts subject to unusual operating conditions.
 - o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 - p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
 - q. Clean ducts, blowers, and coils if units were operated without filters during construction.
 - r. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and high intensity discharge fixtures to comply with requirements for new fixtures.
 - s. Leave the Work and the Jobsite clean and ready for occupancy.
- C. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and treat the Work and the Jobsite for rodents, insects, and other pests. Prepare and submit a report for Pest Control.
- D. Comply with safety standards for cleaning. Do not dispose of waste materials in drains or concealed spaces. Do not burn waste materials. Do not bury debris or excess materials on the GPO's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove all waste materials from the Jobsite and dispose of lawfully.
1. Where extra materials of value remaining after completion of associated Work have become the GPO's property, arrange for delivery and documentation of turnover to the

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

GPO.

END OF SECTION 01 77 00

SECTION 01 78 23 - OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
 - 1. Operation and Maintenance Documentation Directory and formatting.
 - 2. Manuals, General and formatting.
 - 3. Emergency Information Manuals and formatting.
 - 4. Operation Information Manuals and formatting for systems, subsystems, and equipment.
 - 5. Maintenance Information Manuals and formatting for the care and maintenance of products, materials, finishes, systems, and equipment.
 - 6. Warranty Manual.
- B. Related Sections include the following:
 - 1. Division 01 Section "Application for Payment" for values assigned to Operation and Maintenance Manuals.
 - 2. Division 01 Section "Quality Requirements" for ensuring the development and continuing update of the Operation and Maintenance Documentation Directory and Operation and Maintenance Manual.
 - 3. Division 01 Section "Submittals" for submitting copies of submittals for operation and maintenance manuals.
 - 4. Division 01 Section "Project Closeout" for submitting operation and maintenance manuals.
 - 5. Division 01 Section "Project Record Documents" for preparing Record Drawings for operation and maintenance manuals.
 - 6. Construction Documents for specific operation and maintenance manual requirements for products in those Sections.
- C. Payment for materials and equipment will be withheld if complete O & M Manual documentation is not received from the Contractor at time of material or equipment delivery; namely, instruction sheets, operation manuals, installation instructions, and other documents received from the manufacturer at the time of delivery.

1.3 DEFINITIONS

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

- C. Equipment: An instrument or appliance designed for a specific operation.
- D. Product: Items purchased for incorporating into the Work, whether purchased for the Program or Task Order, or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
- E. Location: A defined area such as roof, room, hallway, ceiling, pavement, wall, or floor that has special maintenance requirements that are documented in the Operation and Maintenance Data.

1.4 SUBMITTALS

- A. Operation and Maintenance Manual Format: Submit the proposed Operation and Maintenance Manual Format via the Program Management Software system within 90 calendar days of Notice-to-Proceed for each Task Order for Construction Services. The format shall include a table of contents and be as specified in Part 2 of this Section. The COR will return comments regarding the Operation and Maintenance Manual Format and planned contents of the completed manual within 30 calendar days of receipt. The Contractor shall continue to develop the Operation and Maintenance Manual format and content throughout the Task Order construction period.
- B. Operation and Maintenance Documentation Directory: Submit the Operation and Maintenance Documentation Directory via the Program Management Software within 90 calendar days of Notice-to-Proceed for each Task Order for Construction Services. The format shall be as specified in Part 2 of this section. The COR will return comments regarding the Directory and planned contents of the completed manual set within 30 calendar days of receipt of submittal. The Contractor shall continue to develop the Directory and content throughout the Task Order construction period.
- C. Operation and Maintenance Manuals Initial Submittal: Submit two (2) printed draft printed copies of each Manual in the approved format and submit an electronic copy via the Program Management Software system at least 90 calendar days before requesting inspection for Substantial Completion for a Task Order. Include a copy of the complete Operations and Maintenance Directory. The COR will return a copy of the draft within a minimum of 30 calendar days of receipt, and mark whether general scope and content of Manuals are acceptable.
- D. Operation and Maintenance Manuals Revised Submittals: Submit two (2) printed revised copies of each manual in final form and submit an electronic copy via the Program Management Software system at least 45 calendar days before Substantial Completion or training for each Task Order, whichever occurs first. The COR will return a copy with comments within a minimum of 15 calendar days after receipt.
- E. Operation and Maintenance Manuals Final Submittal: Correct or modify each manual to comply with the COR's comments. Submit two (2) printed copies of the Document Directory and two (2) printed copies of each corrected manual at least 15 calendar days before Substantial Completion or training for each Task Order whichever occurs first:
 - 1. Provide two (2) copies of all Operation and Maintenance Data in electronic format on CD-ROM consistent with the organization and format in the "Manuals, General" section; also submit the Operation and Maintenance Manuals via the Program Management Software system. All electronic files shall be in Adobe PDF format and limited to 10 megabytes in size per file.
 - 2. All information must be legible in the digital versions.

- F. Warranty Manual Draft Submittal: Submit two printed copies of the Warranty Manual at least 90 calendar days before requesting inspection for Substantial Completion for each Task Order. Also, submit the draft Warranty Manual via the Program Management Software system. The COR will return a copy of the draft within a minimum of 30 calendar days of receipt, and mark whether the scope and content of manual is acceptable.
- G. Warranty Manual Final Submittal: Complete, correct and modify the manual to comply with the Contract Documents and the COR's comments. Submit one (1) copy of the Warranty Manual with the original signed warranty documents, one (1) printed copy of the Warranty Manual, and also submit the Warranty Manual electronically via the Program Management Software system. Submit the Final Warranty Manual within 14 days of Substantial Completion.

1.5 COORDINATION

- A. The Contractor shall assemble and coordinate the operation and maintenance information to include that furnished from multiple sources for an installation.

PART 2 PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Provide the Operation and Maintenance Documentation Directory in separate binder from operation and maintenance information. Binders, dividers and all portions of the Directory shall comply with requirements of "Manuals, General" as applicable. Size of binder for directory shall be appropriate for quantity of contents. Information in O & M Directory shall be in alphabetical order with references to the Division and Specification Section contained in the Construction Documents.
- B. Organization: Include a section in the directory for each of the following:
 - 1. General Information.
 - 2. Table of Contents
 - 3. List of systems and subsystems.
 - 4. List of equipment.
 - 5. List of Products
- C. General Information: Include documents that are pertinent to the project, including, but not limited to, a detailed description of the facility or project, general safety information and a user's guide to the project operation and maintenance manuals.
- D. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- E. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list. Include references to operation and maintenance manuals that contain information about each system.
- F. List of Products: List products alphabetically to include all products not part of a system, subsystem, or component of equipment. Include references to operation and maintenance manuals that contain information about each product.

- G. Tables of Contents: Include a complete table of contents for each volume of the Operation and Maintenance Manuals.
- H. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment and products with the same designation used by the GPO. If no designation is provided for equipment, systems, subsystems, or equipment assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."
- I. Submit a draft of the proposed "Operation and Maintenance Documentation Directory" for review at least 90 calendar days before requesting inspection for Substantial Completion.

2.2 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize information by Division and then into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following in the order listed:
 - 1. Title page.
 - 2. Table of contents.
 - 3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information on the title page:
 - 1. Specific subject matter included in manual such as Division number and title, Specification Section number and title, equipment, systems and subsystems.
 - 2. Contract Name and Number.
 - 3. Task Order Name and Number.
 - 4. Date of submittal.
 - 5. Name, address, telephone number, and contact person of the Contractor, Subcontractor, and Supplier.
 - 6. Name and address of Architect/Engineer.
 - 7. Cross-reference to related systems in other portions of the Operation and Maintenance Manuals.
- C. Table of Contents: Include a Table of Contents, printed by a laser printer, for each volume, arranged according to the specification sections. List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in the Construction Documents:
 - 1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents by Division then by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder:
 - 1. Binders: Heavy-duty, 3-ring metal hinged loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents. Binders shall not be filled beyond 75 percent of

their rated capacity. Binders shall also have boomerang plastic sheet lifters, concealed rivet construction, and three-trigger position Dublock mechanism (lock, unlock, open) on top and bottom of binders. Binder color shall be black:

- a. Provide maximum 3-inch binder thickness. Smaller binders are acceptable as long as 75 percent rated binder capacity is not exceeded.
 - b. If two or more binders are necessary to accommodate data for a system, organize data in each binder into groupings by subsystem and related components. Cross reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
 - c. Identify each binder on front (If Identification cannot be placed on the front provide as the first page) and spine of binder, with printed title "OPERATION AND MAINTENANCE MANUAL," Contract number and name, and specific subject matter of contents, such as "Division 23 Heating Ventilating and Air Conditioning". Indicate volume number for multiple-volume sets. The use of business labels is prohibited.
2. Dividers: Provide three-hole, heavyweight, and plastic tabbed dividers for each separate section. Provide laser printed description for each tab section (front and back of tabs), to indicate the appropriate Specification Section. Provide a description of the product or heading for sub tabs using the same laser printed format on the dividers.
3. Provide a typed index describing each product, equipment, and subject addressed in each section on the first page behind each section divider. Include a matching master table of contents for each volume using the same indexing system. Install a colored sheet between major topics and each different device within a tabbed section.
4. Protective Plastic Sleeves: Provide protective transparent plastic sheet protectors to enclose the Title Page, all Table of Content pages, and photographs:
 - a. For CD-ROMs, provide transparent plastic three-ring sleeves designed to accommodate CD-ROMs.
5. Text: Prepared on 8-1/2-by-11-inch, 20-lb/sq. ft. white bond paper. Copies of faxed materials may be rejected. Two-sided text shall be provided on 24-lb/sq. ft. white bond paper to eliminate "bleed through" of text with a minimum brightness of 96.
6. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text:
 - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
 - b. If drawings are too large to be used as foldouts, fold and place drawings in transparent envelopes and bind envelopes with text. Insert typewritten pages indicating drawing titles, descriptions of contents, in the transparent envelopes along with drawings. Drawings shall cross-reference the appropriate manual volume and Specification Section. Drawing holding envelopes are not acceptable.
 - c. Provide operation and maintenance material on CD-ROM.
- E. Transfer Cases: Manuals shall be submitted in durable, multiple thickness fiberboard transfer boxes (legal-size boxes, 15 inches wide by 24 inches long by 10 inches high) with plastic tote handles string and button closures, reinforced poly edge, and a large labeling area that accurately describes the contents:
 1. Approved Product: Bankers Box, "Liberty Plus," Fast Fold, Item No. 12112 or other product as approved by the GPO.

2.3 EMERGENCY INFORMATION

- A. Content: Organize information by Division into a separate section for each of the following:
1. Type of emergency.
 2. Emergency instructions.
 3. Emergency procedures.
- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
 2. Flood.
 3. Gas leak.
 4. Water leak.
 5. Fuel leak.
 6. Power failure.
 7. Water outage.
 8. System, subsystem, or equipment failure.
 9. Chemical release or spill.
 10. Weather related events, thunderstorms, hurricanes, tornados, etc.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of the GPO's operating personnel for notification of Installer, Supplier, and manufacturer to maintain warranties. D. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
 2. Shutdown instructions for each type of emergency.
 3. Operating instructions for conditions outside normal operating limits.
 4. Required sequences for electric or electronic systems.
 5. Special operating instructions and procedures.
- D. Submit a draft of the proposed Emergency Information Manual for approval at least 90 calendar days before requesting inspection for Substantial Completion.

2.4 OPERATION INFORMATION

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information. Organize manuals into separate and distinct volumes by Division:
1. System, subsystem, and equipment descriptions.
 2. Safety instruction and related issues.
 3. Performance and design criteria if the Contractor is delegated design responsibility.
 4. Operating standards.
 5. Operating procedures.
 6. Operating logs.
 7. Wiring diagrams, including color-coding and terminal designations. Include all factory preset or field-set dip switch and jumper settings for all electronic equipment.
 8. Control diagrams.
 9. Piped system diagrams.

10. Precautions against improper use.
 11. License requirements including inspection and renewal dates.
 12. Safety Data Sheets.
- B. Operating Procedures: Include the following, as applicable:
1. Startup procedures.
 2. Equipment or system break-in procedures.
 3. Routine and normal operating instructions.
 4. Regulation and control procedures.
 5. Instructions on stopping.
 6. Normal shutdown instructions.
 7. Seasonal and weekend operating instructions.
 8. Required sequences for electric or electronic systems.
 9. Special operating instructions and procedures.
 10. Procedures or operations that may void warranty.
 11. Copies of equipment warranties.
- C. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- D. Piped Systems: Diagram piping as installed and color-coding shall be used where required for identification.
- E. Submit a draft of the proposed Operation Information Manual for approval at least 90 calendar days before requesting inspection for Substantial Completion.

2.5 PRODUCT MAINTENANCE INFORMATION

- A. This Section shall contain information for all products with the exception of Systems and Equipment, which shall be provided as indicated elsewhere in this Section.
- B. Content: Organize information into a separate section for each product, material, and finish. Provide one section for architectural products, including applied materials and finishes, and a second for products designed for moisture protection and products exposed to the weather. Include source information, product information, maintenance procedures, repair materials and sources, schedule of products, location of products and warranties and bonds, as described below.
- C. Source Information: List each product included in the manual identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer or Supplier and maintenance service agent, and cross reference the Specification Section number and title.
- D. Product Information: Include the following, as applicable:
1. Product name and model number.
 2. Manufacturer's name.
 3. Color, pattern, and texture.
 4. Material and chemical composition.
 5. Reordering information for specially manufactured products.
 6. Fire/flame-spread test certificates.

7. Material Safety Data Sheets.
- E. Maintenance Procedures: Include manufacturer's written recommendations and the following:
 1. Inspection procedures.
 2. Types of cleaning agents to be used and methods of cleaning.
 3. List of cleaning agents and methods of cleaning detrimental to product.
 4. Schedule for routine cleaning and maintenance.
 5. Repair instructions.
 - F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
 - G. Schedule of Products and Locations: Provide complete information, including reference drawings, in the materials and finishes manual on all products specified in the Construction Documents.
 - H. Warranties and Bonds: Provide copies of all applicable warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds:
 1. Include procedures to follow and required notifications for warranty claims.
 2. Clearly indicate commencement and expiration dates.
 - I. Submit a draft of the proposed Product Maintenance Information Manual for approval at least 90 calendar days before requesting inspection for Substantial Completion.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE INFORMATION

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, preventative maintenance program, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below. Organize information into separate and distinct volumes by Division, and further divided into separate volumes by system (for example, HVAC systems and plumbing systems).
- B. Source Information: List each system, subsystem, and piece of equipment included in the manual identified by product name and arranged to match the manual's table of contents. For each product, list the name, address, and telephone number of the installer, Supplier and maintenance service agent, and cross-reference the Specification Section number and title. C. Descriptions: Include the following:
 1. Product name, model number, and location.
 2. Manufacturer's name.
 3. Equipment identification with serial number of each component.
 4. Equipment function.
 5. Operating characteristics.
 6. Limiting conditions.
 7. Performance curves.
 8. Engineering data and tests.
 9. Complete nomenclature and number of replacement parts.
 10. Charts of valve tag numbers, with the room number location and function of each valve.

11. Circuit directories of panelboards for electric and electronic systems, including the following:
 - a. Electric service.
 - b. Controls.
 - c. Telecommunications.
 - d. Computer network.
 - e. Security.
- C. Manufacturers' Maintenance Documentation: Provide manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
 1. Safety information.
 2. Standard printed maintenance instructions and bulletins.
 3. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
 4. Identification and nomenclature of parts and components.
 5. List of items recommended to be stocked as spare parts.
- D. Preventative Maintenance Plan: Provide an annual preventative maintenance plan indicating when maintenance tasks should be performed, such that work is spread evenly as possible throughout the year. Preventative Maintenance should not be misconstrued as reconditioning, or major repairs or replacement of components, but designed to reveal through certain procedures and inspection the need for such actions in time to prevent malfunctions during operation.
- E. Preventative Maintenance and Maintenance and Repair Procedures: Include the following information and items that detail essential preventative maintenance and maintenance and repair procedures:
 1. Preventative Maintenance:
 - a. Provide instructions and location diagrams for the following:
 - 1) Checking general condition of System and Components.
 - 2) Inspecting for accumulation of dust, dirt or any foreign matter, and clean as needed.
 - 3) Cleaning or replacing all filters and screens and adjust packing for pumps, valves, etc.
 - 4) Examining indicating lamps, gauges, thermometers, etc., and replace as required.
 - 5) Checking electrical primary, secondary, terminal blocks and contacts, for loose connections.
 - 6) Checking Operation of strainers, valves, instruments and control switches, including their contacts.
 - 7) Checking instrument transformers for proper condition and replace burned out fuses.
 - 8) Removing dust from all electrical insulators and insulation and inspecting bus bars and connections for proper condition, loose connection, and overheating or overloads.
 - 9) Examining safety interlocks, automatic shutters, dampers, valves, etc., and their operating mechanisms for proper operation.

- 10) Checking space heaters, thermostats, and all controls for proper operation
- 11) Lubricating mechanisms, contacts, and other moving component parts.
- 12) Specific procedures applicable to specialized equipment and systems.

2. Maintenance and Repairs:

- a. Include information and detailed diagnostic testing and inspection instructions, and procedures that detail essential system and equipment maintenance procedures including but not limited to:

- 1) Examination of shaft seal for excessive leakage.
- 2) Monitoring of systems for excessive bearing noise.
- 3) Checking equipment motor housing for excessive heat buildup.
- 4) Measuring and recording suction and discharge pressures.
- 5) Verifying lubrication requirements.
- 6) Realignment of shaft coupling.
- 7) Checking motor amperes drawn at full load.
- 8) Checking motor shaft run-out.
- 9) Performing thermographic scanning of motor starters, motors, pumps, and all mechanical and electrical equipment that requires a connection.
- 10) Proper cleaning and corrosion control of drip pan and drainage lines.
- 11) Inspection of internal equipment components for unusual wear or failure.
- 12) Procedures for maintenance including precautions against improper maintenance.

- b. Include the following information and items that detail essential system and equipment repair procedures:

- 1) Complete troubleshooting guide.
- 2) Complete repair instructions including equipment and component removal, disassembly, repair, and replacement; and reassembly instructions.
- 3) Aligning, adjusting, and checking instructions including noise, vibration, and efficiency adjustments.
- 4) Demonstration and training video, if such video, CD-ROM or DVD is provided by the manufacturer.

F. Maintenance Service Schedules:

1. Provide recommended frequencies, inspections, service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and maintenance and service with standard time allotment:

- a. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
- b. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List, Recommended Inventory Requirements, and Source Information: Include lists of replacement and repair parts, with parts identified, and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent, when specified in the Construction Documents.

- I. Schedule of Products and Locations: Provide complete information, including reference drawings, if necessary, in the Equipment and Systems manual on all products specified in the Construction Documents.
- J. Warranties and Bonds: Include copies of all applicable warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
 - 1. Include procedures to follow and required notifications for warranty claims.
 - 2. Clearly indicate commencement and expiration dates.
- K. Submit a draft of the proposed Product Maintenance Information Manual for approval at least 90 calendar days before requesting inspection for Substantial Completion.

2.7 WARRANTY MANUAL

- A. Organize warranty documents into an orderly sequence based on the table of contents of the technical specification in the Construction Documents. Warranty documents include the Contractor's and major Subcontractor's warranty letters, special warranty documents, and manufacturer's warranties.
- B. Binders: Heavy-duty, 3-ring metal hinged loose-leaf binders in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine
- C. to hold label describing contents. Binders shall not be filled beyond 75 percent of their rated capacity. Binders shall also have boomerang plastic sheet lifters, metal backbone, concealed rivet construction, and three-trigger position DubiLock mechanism (lock, unlock, open) on top and bottom. Binder color shall be black.
- D. Identify each binder on front (If identification cannot be attached to the front include it as the first page in the manual) and spine, with printed title "PROJECT WARRANTIES," contract name and number, and Task Order name and number. The use of business labels is prohibited.
- E. Dividers: Provide three-hole, heavyweight, and tabbed dividers for each separate section. Provide laser printed description front and back of tabs, to indicate the appropriate Specification Section. Provide a typed index of the contents in each section on the first page behind each section divider. Include a matching master table of contents for the manual using the same indexing system. Install a colored sheet between each different warranty within a tabbed section.
- F. Provide additional copies of each warranty to include in operation and maintenance manuals.
- G. Submit a draft of the proposed Warranty Manual for approval at least 90 calendar days before requesting inspection for Substantial Completion.

PART 3 EXECUTION

3.1 MANUAL PREPARATION

- A. Compile all required information, as it is approved, into volumes grouped first by specification Division and then by Section in accordance with the information requirements outlined in Part 2 of this specification section and the approved Operation and Maintenance Manual Format.

- B. For the first Directory Submittal, prepare a separate manual that provides an organized reference to the complete manual set. Subsequent submittals of the Directory shall integrate this information by Division.
- C. Emergency Information: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by the GPO's operating personnel for types of emergencies indicated. Include the emergency information in the volume of the manual set to which it applies.
- D. Product Maintenance Information: For Divisions that specify products assemble a complete set of maintenance data indicating manufacturer's product information, part numbers, description, and care and maintenance instructions for each product, material, and finish incorporated into the Work. Provide sufficient information, and when applicable color samples, for all products to enable repair or replacement of matching products or finishes.
- E. Operation and Maintenance Information: For Divisions that specify systems, sub-systems, and equipment assemble a complete set of operation and maintenance and repair data providing complete information for each system, subsystem, and piece of equipment. Include complete operation, preventative maintenance, maintenance and repair instructions, and parts listing with sources indicated; recommended parts inventory listing, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel:
 - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
 - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by the GPO's operating personnel.
- F. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet with black arrows to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Construction Documents. Identify data applicable to the Work and delete references to information not applicable:
 - 1. Provide supplementary text if manufacturers' standard printed data is not provided by the manufacturer. Provide supplementary text where the information is necessary for proper operation and maintenance of equipment or systems.
- G. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams and their relation to the structure or facility. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation. Prepare floor plans that show the location of equipment in the building:
 - 1. Do not use original Project Record Documents as part of Operation and Maintenance Manuals.
 - 2. Comply with requirements of newly prepared Record Drawings in Division 01 Section "Project Record Documents."
- H. Comply with Division 01 Section "Project Closeout" for a schedule for submitting operation and maintenance documentation.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20002

END OF SECTION 01 78 23

SECTION 01 78 39 - PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 Related Documents

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Record Samples.
5. Record As-built CPM Schedule.
6. Miscellaneous Record Submittals.
7. Computer Aided Design and Drafting (CADD) requirements for Record Drawings.

- B. Related Sections include the following:

1. Division 01 Section "Construction Progress Documentation" for construction schedules as basis for Record As-built CPM Schedule.
2. Division 01 Section "Quality Requirements" for ensuring the record drawings and specifications are kept current on a daily basis and marked to show deviations which have been made from the original Construction Documents.
3. Division 01 Section "Project Closeout " for general closeout procedures.
4. Division 01 Section "Operation and Maintenance Data" for operation and maintenance manual requirements.
5. Construction Documents for specific requirements for Project Record Documents of products in those Sections.

1.3 SUBMITTALS

- A. CADD Record Drawings. Comply with the following:

1. Submit copies of CADD Record Drawings as follows:
 - a. Initial Submittal: Submit one set of complete, full-sized, CADD Record Drawings. Additional sets of drawings are not to be copied and submitted until after Substantial Completion to ensure all changes are shown on the drawings. The COR will facilitate review of drawings and indicate whether the CADD Record Drawings are acceptable. The COR will return review comments indicating any corrections that need to be made to the drawings. The corrected CADD Record Drawings may then be reproduced, and organized into sets, printed, bound, and submitted as final submittal.

- B. Final Submittal: After construction is complete and changes are recorded, submit three (3) complete, full-sized, printed sets of CADD Record Drawings. Include each sheet, whether or not changes and additional information were recorded. Submit two copies of the CADD Record drawings in the approved electronic format. In addition, submit the original set of marked-up record drawings onto which the mark-ups were made.
- C. Record Specifications: Submit an electronic copy of the Record Specifications, including any addenda and contract modifications.
- D. Record Product Data: Submit an electronic copy of each Product Data submittal at the direction of the COR:
 - 1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product Data as an insert in the manual instead of submittal as Record Product Data.
- E. Record Samples: Submit Record Samples as specified.
- F. Record As-built CPM Schedule: Submit an electronic copy of Record As-built CPM Schedule.
- G. Miscellaneous Record Submittals: Submit miscellaneous Record Submittals as specified in the Construction Documents and other Division 1 Specification Sections.

PART 2 PRODUCTS

2.1 RECORD DRAWINGS

- A. Record Prints: During construction, maintain one complete, full sized, set of blue- or black-line prints of the Construction Document drawings, applicable shop drawings, and coordination drawings for record purposes. These drawings shall be updated periodically, by the Contractor, in CADD to replace the hand mark-ups. The mark-ups shall be preserved for the record. A complete set of Conformed Drawings in CADD will be provided to the Contractor for his use in maintaining the CADD Record Drawings. The format for the CADD files will be determined during the Pre-Construction Phase Services:
 - 1. Maintenance of Drawings: Maintain the drawings in a clean, dry, legible condition. Keep drawings available during normal working hours for inspection by the COR.
 - 2. Preparation: Routinely mark Record Prints to show the actual installation where installation varies from that shown originally. Require the individual or entity who obtained the record data, whether the individual or entity is the installer, Subcontractor, or similar entity, to prepare the mark-ups on the record set:
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later especially underground structures and utilities.
 - b. Record information in an understandable drawing technique. Ensure mark-ups are legible and reproducible.
 - c. Record data as soon as possible after obtaining it. Record and check markups before enclosing concealed installations.

- d. When there are multiple copies of the same sheet with different mark-ups on each copy, the Contractor is responsible for consolidating all mark-ups onto a single copy of each individual sheet.
 - e. Notes and sketches printed by hand are acceptable but shall be neat, legible, and reproducible. Hand lettering shall be 3/8" high minimum.
- 3. Content: Types of items requiring marking include, but are not limited to, the following:
 - a. Contract Modifications.
 - b. Shop drawings.
 - c. Coordination Drawings.
 - d. Dimensional revisions to the Drawings.
 - e. Revisions to details shown on the Drawings.
 - f. Details not on the original Drawings.
 - g. Depths of foundations below first floor.
 - h. Locations, depths, sizes and types of underground utilities (new and existing).
 - i. Locations, sizes and types of concealed internal utilities (new and existing).
 - j. Duct sizes and routing.
 - k. Revisions to routing of piping and conduits.
 - l. Revisions to electrical circuitry.
 - m. Actual equipment locations.
 - n. Field records, including photographs, for underground or concealed conditions.
 - o. Schematic information for the Work.
- 4. Mark the Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, insert them into the drawing set and assign an appropriate sheet number (one that follows the number sequence of the contract drawings). Show cross-references to the new sheets on the Drawings. Update the drawing index as needed to reflect new sheets.
- 5. Mark the record drawings with red pen that will reproduce clearly. Use different colors to distinguish between changes for different categories of the Work at the same location.
- 6. Mark pertinent record information that was either shown schematically or not indicated on the original Drawings.
- 7. Note applicable Contract Modifications, Requests for Information, and similar identification numbers, where applicable. Documentation may be inserted into the set for clarification, but not as a substitute for the Record Drawing mark-up. If identification numbers for documentation are marked on the drawing when no change resulted, indicate "No Change".
- B. Newly Prepared Project Record Drawing Sheets: The Contractor may add new sheets with supporting sketches and change documentation instead of marking original sheets when neither the original Drawings nor Shop Drawings are suitable to show actual installation or if the new sheets can show the changes more clearly or additional space is required for markup information:
 - 1. Assign a number to each new sheet and cross-reference on the appropriate related sheets.
 - 2. Consult with COR for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction.
 - 3. Integrate newly prepared sheets into the Record Drawing set and update the drawing index to reflect new sheets.
- C. Format:

1. Record CADD Drawings:
 - a. CADD files provided by COR and utilized for recording of record mark-ups shall maintain the format of the files provided. Place electronic mark-ups in a newly created layer on each drawing.
 - b. CADD files created by the Contractor: Organize CADD information into separate electronic files that correspond to each sheet of the Record Drawing set. Name each file with the sheet identification. Include identification in each CADD file.
2. Include the following identification on all Project Record Drawing Sheets:
 - a. Construction Work Package name.
 - b. Date.
 - c. Designation "PROJECT RECORD DRAWING."
 - d. Name of Architect/Engineer (if applicable).
 - e. Name of the Contractor.
 - f. Initials of person incorporating the change.
 - g. Drawing identification number. (lxx/Dxx)
3. Organization of Newly Prepared Project Record Drawing Prints: Organize newly prepared Record Drawings into manageable sets. Include any contract required coordination drawings and applicable shop drawings. Bind each set with durable paper cover sheets. Include identification on cover sheets.

2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark the Specifications to indicate the actual product installation. Print marked specifications, addenda, and contract modifications on paper any color but white and ensure that black font is clearly legible on the color chosen. Use the same paper color throughout the project. Use black font for these changes:
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Mark copy with the brand name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
 3. Record the name of the manufacturer, Supplier, Installer, and other information necessary to provide a record of selections made.
 4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.

2.3 RECORD PRODUCT DATA

- A. Preparation: Document the Record Product Data to indicate the actual product installation:
 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
 2. Include significant changes in the product delivered to the Jobsite and changes in manufacturer's written instructions for installation.
 3. Upon completion of mark-up, submit a complete set of the Record Product Data for the GPO's records.

4. Where Record Product Data is required as part of maintenance manuals, submit marked-up product data as an insert in the manual.

2.4 RECORD SAMPLE SUBMITTAL

- A. Prior to the date of Substantial Completion for the Task Order, the Contractor shall meet with the COR to determine which of the samples maintained during the construction period shall be transmitted to the GPO for record purposes. Comply with the COR's instructions for packaging, identification marking, and delivery to the GPO's sample storage space. Dispose of other samples in manner specified for disposal of surplus and waste materials.

2.5 RECORD AS-BUILT CPM SCHEDULE

- A. Record As-built CPM Schedule Submittal: Prior to the Final Completion and Acceptance Inspection, submit the Record As-built CPM Schedule for the Construction Work Package.

2.6 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Submit for review.

1. Categories of requirements resulting in miscellaneous records may include, but are not limited to the following:
 - a. Field records on excavations and foundations.
 - b. Field records on underground construction and similar Work.
 - c. Survey showing locations and elevations of structures and utilities.
 - d. Invert elevations of drainage piping.
 - e. Surveys establishing building lines and levels.
 - f. Measurements records for all Construction Services Approved Direct Cost items paid on the basis of unit prices and actual quantity.
 - g. Certifications received in lieu of labels on bulk products.
 - h. Inspections and certifications by governing authorities.
 - i. Summary letter from Special Inspector indicating structural work was completed in accordance with applicable standards.
 - j. Approvals of Health Department or FDA as applicable.
 - k. Performance test results.
 - l. Leakage and water-penetration test results.
 - m. Fire resistance and flame spread test results.
 - n. Report of potable water testing.
 - o. Backflow prevention certificates.
 - p. Certificates for piping for fire protection systems and FPS supervisory systems.

PART 3 EXECUTION

3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Construction Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Repair or reproduce torn or dirty sheets. Provide access to Project Record Documents for the GPO reference during normal working hours.

END OF SECTION 01 78 39

SECTION 01 79 00 - DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provision of the contract, including General and Supplementary conditions, other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes administrative and procedural requirements for instructing the GPO's personnel, including the following:
 - 1. Demonstration of operation of systems, subsystems, and equipment.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Related Sections include the following:
 - 1. Division 01 Section "Application for Payment for cost values assigned to Demonstration and Training requirements.
 - 2. Division 01 Section "Project Management and Coordination" for requirements for pre-instruction conferences.
 - 3. Division 01 Section "Operation and Maintenance Data for preparing and submitting demonstration and training agenda and course of study.

1.3 SUBMITTALS

- A. Instruction Program: Submit the outline of instructional program for demonstration and training via the Program Management Software system 90 calendar days prior to request for Substantial Completion inspection. The submittal is to include: a schedule of proposed dates, times, length of instruction time, and the instructors' names and qualifications for each training module. Include learning objective and outline for each training module:
 - 1. Provide two separate sessions per module. One session per module shall be conducted after normal working hours.
 - 2. At completion of training, submit a complete set of the training manuals via the Program Management Software for the GPO use; and also submit two (2) copies in electronic format on CD-ROM.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article provide credentials 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. Provide credentials to demonstrate the capabilities and experience of firms required by this Section.
- C. Attendance Record: For each training module, submit list of participants and length of instruction time.

- D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
- E. Demonstration and Training Video: Submit two copies at end of each training module on media that will play in a standard DVD player.

1.4 QUALITY ASSURANCE

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project. Provide 4 references for the Facilitator's firm that will be used to determine if their training and education has indicated a record of successful learning performance.
- B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
- C. Videographer Qualifications: A videographer who is a trained professional with a minimum of five years' experience in video recording training sessions.
- D. Pre-instruction Conference: Conduct conference at the Jobsite to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:
 - 1. Inspect and discuss locations and other facilities required for instruction.
 - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
 - 3. Review required content of instruction.
 - 4. Review weather, forecasted weather conditions, and procedures to follow if conditions are unfavorable for instruction that must occur outside.

1.5 COORDINATION

- A. Coordinate the instruction schedule with the GPO's operations and work schedule. Adjust the schedule as required to avoid disruption of the GPO's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training agenda with content of approved emergency, operation, and maintenance manuals. Do not submit the instruction program until the operation and maintenance data has been submitted, reviewed and approved.
- D. Ensure that approved Operations and Maintenance Manuals are available prior to conducting any training.

PART 2 PRODUCTS

2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop an instruction program that includes individual training agenda for each system, sub system, and equipment. Develop an instruction program for equipment that is not part of a system or a subsystem, as required by individual Specification Sections, and as follows:
- B. Training Agenda: Develop a learning objective and teaching outline for each agenda. Submit 45 calendar days prior to request for Substantial Completion inspection. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following:
 - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
 - a. System, subsystem, and equipment descriptions.
 - b. Performance and design criteria if the Contractor is delegated design responsibility.
 - c. Operating standards.
 - d. Regulatory requirements.
 - e. Equipment function.
 - f. Operating characteristics.
 - g. Limiting conditions.
 - h. Performance curves.
 - 2. Documentation: Review the following items in detail:
 - a. Emergency manuals.
 - b. Operations manuals.
 - c. Maintenance manuals.
 - d. Project Record Documents.
 - e. Identification systems.
 - f. Hazards/Material Safety Data Sheets.
 - g. Warranties and bonds.
 - h. Maintenance service agreements and similar continuing commitments.
 - 3. Emergencies: Include the following, as applicable:
 - a. Instructions on meaning of warnings, trouble indications, and error messages.
 - b. Instructions on stopping.
 - c. Shutdown instructions for each type of emergency.
 - d. Operating instructions for conditions outside of normal operating limits.
 - e. Sequences for electric or electronic systems.
 - f. Special operating instructions and procedures.
 - 4. Operations: Include the following, as applicable:
 - a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.

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

PART 3 EXECUTION

3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training agenda into a combined training manual.
- B. Provide conditioned space with tables and chairs for conducting the classroom portion of all training.
- C. Provide instructional equipment at instruction location.

3.2 INSTRUCTION

- A. Facilitator: Engage a qualified facilitator to prepare the instruction program and training agenda, to coordinate instructors, and to coordinate between the Contractor and the COR for the number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct the GPO's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system:
 - 1. Furnish an approved instructor to describe the basis of each system designed for this project, operational requirements, criteria, and regulatory requirements.
 - 2. The GPO will provide an estimate of the number of staff that will attend each training session, and the Contractor is to document attendance with a sign sheet. The sign-in sheet is to be submitted by the Contractor as a record document.
- C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season:
 - 1. Schedule training with the COR with at least 15 calendar days' advance notice.
 - 2. Submit a daily training agenda (module) for review and approval for each system/equipment no later than 15 calendar days prior to the scheduled date for system or equipment commissioning and turnover. After obtaining approval of the training agenda, the Contractor is to submit a list proposed dates, times, and locations for the training. The GPO will response to confirm the selected dates, times, and locations, or to request alternate dates and times.
- D. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, a written or a demonstration performance-based test.
- E. Demonstration and Training Video: Record the instruction of the GPO's personnel in the operation and maintenance of equipment and systems. Edit video to remove non-instructional conversation. Videographer shall select vantage points to best show equipment, systems, and procedures demonstrated. Provide movie file of each unique training session in its entirety. Record video at a recording quality equal to a standard DVD:
 - 1. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
 - 2. At beginning of each training module, record each chart containing learning objective and lesson outline.
- F. Cleanup: Collect used and leftover educational materials and remove from the Jobsite. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

END OF SECTION 01 79 00

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Form-facing material for cast-in-place concrete.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction, movement, and isolation joints
 - c. Forms and form-removal limitations.

1.5 ACTION SUBMITTALS

- A. Product Data: For each of the following:
 - 1. Exposed surface form-facing material.
 - 2. Concealed surface form-facing material.
 - 3. Form-release agent.

- B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.
 - 1. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301 (ACI 301M).
 - a. Location of construction joints is subject to approval of the Architect.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Field quality-control reports.
- C. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
 - 1. Provide continuous, true, and smooth concrete surfaces.
 - 2. Furnish in largest practicable sizes to minimize number of joints.
 - 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete, and as follows:
 - a. Plywood, metal, or other approved panel materials.
 - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - 1) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
 - 2) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
 - 3) APA Plyform Class I, B-B or better; mill oiled and edge sealed.
- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
 - 1. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 RELATED MATERIALS

- A. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301 (ACI 301M).
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 (ACI 117M) and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
 - 1. Surface Finish-2.0: ACI 117 Class B, 1/4 inch (6 mm).
- D. Construct forms tight enough to prevent loss of concrete mortar.
 - 1. Minimize joints.
 - 2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
 - 1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
 - 2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
 - 1. Provide and secure units to support screed strips
 - 2. Use strike-off templates or compacting-type screeds.
- H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.
 - 1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
 - 2. Locate temporary openings in forms at inconspicuous locations.
- I. Do not chamfer exterior corners and edges of permanently exposed concrete.

- J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches (305 mm).
- K. Form openings, chases, offsets, screeds, and bulkheads required in the Work.
 - 1. Determine sizes and locations from trades providing such items.
 - 2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.
- L. Construction and Movement Joints:
 - 1. Construct joints true to line with faces perpendicular to surface plane of concrete.
 - 2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 3. Place joints perpendicular to main reinforcement.
 - 4. Locate joints for slabs in the middle third of spans.
- M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.
 - 1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
 - 2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.
- N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- P. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 REMOVING AND REUSING FORMS

- A. Formwork for sides of topping slabs and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
- B. Clean and repair surfaces of forms to be reused in the Work.
 - 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
 - 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
 - 1. Align and secure joints to avoid offsets.
 - 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 - 1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 03 10 00

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction contraction and isolation joints.
 - c. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, and supports for concrete reinforcement.

C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Field quality-control reports.

- C. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.
 - 1. Store reinforcement to avoid contact with earth.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

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.
 - 1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch (1.2908 mm) in diameter.
 - 1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

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

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
 - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch (25 mm), 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 (ACI 318M).
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
 - 1. Bars indicated to be continuous to be lapped not less than 36 bar diameters at splices, or 24 inches (610 mm), whichever is greater.
 - 2. Stagger splices in accordance with ACI 318 (ACI 318M).
- G. Install welded-wire reinforcement in longest practicable lengths.
 - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
 - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches (305 mm).
 - 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches (50 mm) for plain wire and 8 inches (200 mm) for deformed wire.
 - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
 - 4. Lace overlaps with wire.

3.3 JOINTS

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

3. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117 (ACI 117M).

3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
 1. Steel-reinforcement placement.

END OF SECTION 03 20 00

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

B. Related Requirements:

1. Section 03 10 00 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 03 20 00 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.

1.2 DEFINITIONS

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

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete Subcontractor.
2. Review the following:
 - a. Special inspection and testing and inspecting agency procedures for field quality control.
 - b. Construction joints.
 - c. Concrete finishes and finishing.
 - d. Curing procedures.
 - e. Forms and form-removal limitations.
 - f. Methods for achieving specified floor and slab flatness and levelness.

- g. Floor and slab flatness and levelness measurements.
- h. Concrete repair procedures.
- i. Concrete protection.
- j. Initial curing and field curing of field test cylinders (ASTM C31/C31M.)
- k. Protection of field cured field test cylinders.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

- 1. Portland cement.
- 2. Fly ash.
- 3. Slag cement.
- 4. Blended hydraulic cement.
- 5. Aggregates.
- 6. Admixtures:
 - a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
- 7. Fiber reinforcement.
- 8. Repair materials.

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

- 1. Mixture identification.
- 2. Minimum 28-day compressive strength.
- 3. Durability exposure class.
- 4. Maximum w/cm.
- 5. Calculated equilibrium unit weight, for lightweight concrete.
- 6. Slump limit.
- 7. Air content.
- 8. Nominal maximum aggregate size.
- 9. Synthetic micro-fiber content.
- 10. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
- 11. Intended placement method.
- 12. Submit alternate design mixtures when characteristics of materials, Project conditions, test results, or other circumstances warrant adjustments.

C. Shop Drawings:

- 1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - a. Location of construction joints is subject to approval of the Architect.

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

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

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

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

1. Cementitious materials.
2. Admixtures.
3. Fiber reinforcement.
4. Bonding agents.
5. Adhesives.
6. Repair materials.

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

1. Portland cement.
2. Fly ash.
3. Slag cement.
4. Blended hydraulic cement.
5. Aggregates.
6. Admixtures:

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

E. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.

F. Preconstruction Test Reports: For each mix design.

G. Field quality-control reports.

H. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.
 - 1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.
- B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
 - 1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.
 - 1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor to be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Field Quality-Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
 - 1. Personnel conducting field tests to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.
 - 1. Include the following information in each test report:
 - a. Admixture dosage rates.
 - b. Slump.
 - c. Air content.
 - d. Seven-day compressive strength.
 - e. 28-day compressive strength.

1.8 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

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

2.2 CONCRETE MATERIALS

- A. Source Limitations:

- 1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
 - 2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
 - 3. Obtain aggregate from single source.
 - 4. Obtain each type of admixture from single source from single manufacturer.

- B. Cementitious Materials:

- 1. Portland Cement: ASTM C150/C150M, Type I or Type II
 - 2. Fly Ash: ASTM C618, Class C or F.
 - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
 - 4. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag cement.

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

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

- a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
 - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
 - c. Alkali Content in Concrete: Not more than 4 lb./cu. Yd. for moderately reactive aggregate or 3 lb./cu. Yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301 (ACI 301M).

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

- D. Lightweight Aggregate: ASTM C330/C330M, 1-inch (25-mm) nominal maximum aggregate size.

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

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

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

2.3 FIBER REINFORCEMENT

- A. Synthetic Monofilament Micro-Fiber: Monofilament polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116/1116M, Type III, 1 to 2-1/4 inches long.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
- B. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
- C. Water: Potable or complying with ASTM C1602/C1602M.

2.5 RELATED MATERIALS

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

2.6 REPAIR MATERIALS

- A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.

4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested in accordance with ASTM C109/C109M.

2.7 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301 (ACI 301M).
 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 1. Fly Ash or Other Pozzolans: 25 percent by mass.
 2. Slag Cement: 50 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
 1. Use water-reducing, high-range water-reducing, or plasticizing admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, and concrete with a w/cm below 0.50.

2.8 CONCRETE MIXTURES

- A. Class A: Structural lightweight concrete used for interior slabs on metal deck.
 1. Exposure Class: ACI 318 (ACI 318M) F0, S0, W0, C0.
 2. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
 3. Calculated Equilibrium Unit Weight: 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C567/C567M.
 4. Slump Limit: 8 inches (200 mm), plus or minus 1 inch (25 mm) for concrete with verified slump of 3 inches ((75 mm),) plus or minus 1 inch ((25 mm),) before adding high-range water-reducing admixture or plasticizing admixture at Project site.
 5. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
- B. Class B: Structural lightweight concrete used for concrete topping slabs.
 1. Exposure Class: ACI 318 (ACI 318M) F0, S0, W0, C0.
 2. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
 3. Minimum Cementitious Materials Content: 520 lb/cu. yd. (309 kg/cu. m).

4. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
 5. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent for concrete used in trowel-finished floors.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.
 7. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 1/5 lb/cu. yd.
- C. Class C: Normal-weight concrete used for building frame members and housekeeping pads.
1. Exposure Class: ACI 318 (ACI 318M) F0, S0, W0, C0.
 2. Minimum Compressive Strength: 4000 psi at 28 days.
 3. Maximum w/cm: 0.45.
 4. Slump Limit: 8 inches, plus or minus 1 inch for concrete with verified slump of 3 inches plus or minus 1 inch before adding high-range water-reducing admixture or plasticizing admixture at project site.
 5. Air Content:
 - a. Do not use an air-entraining admixture or allow total air content to exceed 3 percent.
 6. Limit water-soluble, chloride-ion content in hardened concrete to 1.00 percent by weight of cement.

2.9 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and ASTM C1116/1116M, and furnish batch ticket information.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
 1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
 2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
 3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

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

3.2 PREPARATION

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

1. 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 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.
2. Place joints perpendicular to main reinforcement.
 - a. Continue reinforcement across construction joints unless otherwise indicated.
 - b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
4. Locate joints for slabs at third points of spans.
5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

3.4 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork and reinforcement is complete and that required inspections are completed.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Project Manager in writing, but not to exceed the amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M), but not to exceed the amount indicated on the concrete delivery ticket.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
 - 1. If a section cannot be placed continuously, provide construction joints as indicated.
 - 2. Deposit concrete to avoid segregation.
 - 3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301 (ACI 301M).
 - a. Do not use vibrators to transport concrete inside forms.
 - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer.
 - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
 - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Do not place concrete floors and slabs in a checkerboard sequence.
 - 2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 3. Maintain reinforcement in position on chairs during concrete placement.
 - 4. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 5. Level concrete, cut high areas, and fill low areas.
 - 6. Slope surfaces uniformly to drains where required.

7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.5 FINISHING FORMED SURFACES

A. As-Cast Surface Finishes:

1. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.
 - a. Patch voids larger than 3/4 inch (19 mm) wide or 1/2 inch (13 mm) deep.
 - b. Remove projections larger than 1/4 inch (6 mm).
 - c. Patch tie holes.
 - d. Surface Tolerance: ACI 117 (ACI 117M) Class B.
 - e. Locations: Apply to concrete surfaces exposed to public view, or to receive a rubbed finish.

B. Rubbed Finish: Apply the following to as cast surface finishes where indicated on Drawings:

1. Smooth-Rubbed Finish:
 - a. Perform no later than one day after form removal.
 - b. Moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture.
 - c. If sufficient cement paste cannot be drawn from the concrete by the rubbing process, use a grout made from the same cementitious materials used in the in-place concrete.

3.6 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture and complies with ACI 117 (ACI A117M) tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.

C. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.

2. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view
7. Finish surfaces to the following tolerances, in accordance with ASTM E1155 (ASTM E1155M), for a randomly trafficked floor surface:
 - a. Suspended Slabs:
 - 1) Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- (3.05-m-) long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch (4.8 mm).
 - 2) Specified overall values of flatness, F_F 35; and of levelness, F_L 20; with minimum local values of flatness, F_F 24; and of levelness, F_L 15.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

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

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches (150 mm) high unless otherwise indicated on Drawings, and extend base not less than 6 inches (150 mm) in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.
 - a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - b. Cast anchor-bolt insert into bases.

- c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.8 CONCRETE CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
 1. Maintain moisture loss no more than 0.2 lb/sq. ft. x h (1 kg/sq. m x h), calculated in accordance with ACI 305.1,) before and during finishing operations.
- B. Curing Formed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
 2. If forms remain during curing period, moist cure after loosening forms.
 3. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
 - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
 - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
 - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
 - d. Water-Retention Sheetting Materials: Cover exposed concrete surfaces with sheetting material, taping, or lapping seams.
- C. Curing Unformed Surfaces: Comply with ACI 308.1 (ACI 308.1M) as follows:
 1. Begin curing immediately after finishing concrete.
 2. Interior Concrete Floors:
 - a. Floors to Receive Floor Coverings Specified in Other Sections: Contractor has option of the following:
 - 1) Absorptive Cover: As soon as concrete has sufficient set to permit application without marring concrete surface, install prewetted absorptive cover over entire area of floor.
 - a) Lap edges and ends of absorptive cover not less than 12 inches (300 mm).
 - b) Maintain absorptive cover water saturated, and in place, for duration of curing period, but not less than seven days.
 - 2) Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive.
 - a) Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

- b) Cure for not less than seven days.
- 3) Ponding or Continuous Sprinkling of Water: Maintain concrete surfaces continuously wet for not less than seven days, utilizing one, or a combination of, the following:
 - a) Water.
 - b) Continuous water-fog spray.

3.9 TOLERANCES

- A. Conform to ACI 117 (ACI 117M).
- B. After concrete has cured, polish top surface of fiber-reinforced topping slabs as necessary for floor finish application.

3.10 CONCRETE SURFACE REPAIRS

- A. Defective Concrete:
 - 1. Repair and patch defective areas when approved by Architect.
 - 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete.
 - a. Limit cut depth to 3/4 inch (19 mm).
 - b. Make edges of cuts perpendicular to concrete surface.
 - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
 - d. Fill and compact with patching mortar before bonding agent has dried.
 - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent,
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
 - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
 - b. Compact mortar in place and strike off slightly higher than surrounding surface.

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

D. Repairing Unformed Surfaces:

1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
 - a. Correct low and high areas.
 - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
 - a. Finish repaired areas to blend into adjacent concrete.
5. Correct other low areas scheduled to remain exposed with repair topping.
 - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations.
 - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete.
 - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around.
 - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
 - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
 - d. Place, compact, and finish to blend with adjacent finished concrete.
 - e. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar.
 - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
 - b. Dampen cleaned concrete surfaces and apply bonding agent.
 - c. Place patching mortar before bonding agent has dried.
 - d. Compact patching mortar and finish to match adjacent concrete.
 - e. Keep patched area continuously moist for at least 72 hours.

- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.11 FIELD QUALITY CONTROL

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

4. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C143/C143M:
 - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - b. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C173/C173M volumetric method, for structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C1064/C1064M:
 - a. One test hourly when air temperature is 40 deg F (4.4 deg C) and below or 80 deg F (27 deg C) and above, and one test for each composite sample.
 5. Unit Weight: ASTM C567/C567M fresh unit weight of structural lightweight concrete.
 - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 6. Compression Test Specimens: ASTM C31/C31M:
 - a. Cast and laboratory cure two sets of three 6-inch (150 mm) by 12-inch (300 mm) or 4-inch (100 mm) by 8-inch (200 mm) cylinder specimens for each composite sample.
 7. Compressive-Strength Tests: ASTM C39/C39M.
 - a. Test one set of two laboratory-cured specimens at seven days and one set of two specimens at 28 days.
 - b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
 9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive

strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa) if specified compressive strength is 5000 psi (34.5 MPa), or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi (34.5 MPa).

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

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

3.12 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.

END OF SECTION 03 30 00

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Shrinkage-resistant grout.

B. Related Requirements:

1. Section 05 31 00 "Steel Decking" for field installation of shear stud connectors through deck.
2. Section 09 96 00 "High-Performance Coatings" for painting requirements.

1.2 DEFINITIONS

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

1.3 COORDINATION

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

1.4 PREINSTALLATION MEETINGS

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

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shop primer.
4. Galvanized repair paint.
5. Shrinkage-resistant grout.

6. Post-Installed Adhesive Anchors.

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

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.
5. Identify members not to be shop primed.

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

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

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator, shop-painting applicators, and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control reports.

1.7 QUALITY ASSURANCE

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

- C. Shop-Painting Applicators: Qualified in accordance with AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3.
- D. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. ANSI/AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Construction: Braced frame.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes and Channels: ASTM A992/A992M.
- B. Angles: ASTM A36/A36M.
- C. Plates: ASTM A36/A36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade C structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.

1. Weight Class: Standard.
2. Finish: Galvanized.

F. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
- B. Zinc-Coated High-Strength A325 Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S), heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
 1. Finish: Hot-dip zinc coating.
- C. Post-Installed Adhesive Anchors: Adhesive anchors for concrete shall be HILTI HIT-HY 200 or an approved equivalent with accompanying ICC Evaluation Report.

2.4 PRIMER

- A. Steel Primer:
 1. Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.5 SHRINKAGE-RESISTANT GROUT

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

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 1. Fabricate beams with rolling camber up.
 2. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 3. Mark and match-mark materials for field assembly.
 4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.

2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for type of bolt and type of joint specified.
 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

2.9 SHOP PRIMING

- A. Shop prime steel surfaces, except the following:
 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces to be field welded.
 3. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 4. Galvanized surfaces.
- B. Surface Preparation of Steel: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces in accordance with the following specifications and standards:
 1. SSPC-SP 2.
 2. SSPC-SP 3.

3. SSPC-SP 6 (WAB)/NACE WAB-3.

- C. Surface Preparation of Galvanized Steel: Prepare galvanized-steel surfaces for shop priming by thoroughly cleaning steel of grease, dirt, oil, flux, and other foreign matter, and treating with etching cleaner or in accordance with SSPC-SP 16.
- D. Priming: Immediately after surface preparation, apply primer in accordance with manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform shop tests and inspections.
 - 1. Allow testing agency access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
 - 2. Bolted Connections: Inspect and test shop-bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 3. Welded Connections: Visually inspect shop-welded connections in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E165/E165M.
 - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - c. Ultrasonic Inspection: ASTM E164.
 - d. Radiographic Inspection: ASTM E94/E94M.
 - 4. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete -bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 - 1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates and Leveling Plates: Clean concrete -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 shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

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

- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

3.5 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting:
 - 1. Immediately after erection, clean exposed areas where primer is damaged or missing, and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Priming: Cleaning and touchup priming are specified in Section 099600 "High-Performance Coatings."

3.6 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform the following special inspections:
 - 1. Verify structural-steel materials and inspect steel frame joint details.
 - 2. Verify weld materials and inspect welds.
 - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. Bolted Connections: Inspect and test bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 - 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.
 - a. In addition to visual inspection, test and inspect field welds in accordance with AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
 - 1) Liquid Penetrant Inspection: ASTM E165/E165M.
 - 2) Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
 - 3) Ultrasonic Inspection: ASTM E164.
 - 4) Radiographic Inspection: ASTM E94/E94M.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents Submission

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington DC, 20401

END OF SECTION 05 12 00

SECTION 05 31 00 - STEEL DECKING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Composite floor deck.

B. Related Requirements:

1. Section 03 30 00 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 05 12 00 "Structural Steel Framing" for shop- and field-welded shear connectors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Composite floor deck.

B. Shop Drawings:

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

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Welding certificates.
2. Product Certificates: For each type of steel deck.

B. Test and Evaluation Reports:

1. Research Reports: For steel deck, from ICC-ES showing compliance with the building code.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

D. Qualification Statements: For welding personnel and testing agency.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Welding Qualifications: Qualify procedures and personnel in accordance with SDI QA/QC and the following welding codes:
 - a. AWS D1.3/D1.3M.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Store products in accordance with SDI MOC3. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck in accordance with AISI S100.

2.2 COMPOSITE FLOOR DECK

- A. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with SDI C, with the minimum section properties indicated, and with the following:
 1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 50 (340), G60 (Z180) zinc coating.
 2. Profile Depth: 3 inches (76 mm).
 3. Design Uncoated-Steel Thickness: 0.0358 inch (0.91 mm).
 4. Span Condition: Simple span or double span.

2.3 ACCESSORIES

- A. Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI standards for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch (1.52 mm) thick, with factory-punched hole of 3/8-inch (9.5-mm) minimum diameter.
- I. Galvanizing Repair Paint: ASTM A780/A780M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

- A. Install deck panels and accessories in accordance with SDI C, SDI NC, and SDI RD, as applicable; manufacturer's written instructions; and requirements in this Section.
- B. Locate deck bundles to prevent overloading of supporting members.
- C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
- D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

- H. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install in accordance with deck manufacturer's written instructions.

3.3 INSTALLATION OF FLOOR DECK

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
 - 1. Weld Diameter: 5/8 inch (16 mm), nominal.
 - 2. Weld Spacing:
 - a. Weld edge ribs of panels at each support. Space additional welds an average of 16 inches (400 mm) apart, but not more than 18 inches (460 mm) apart.
 - 3. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches (1 m), and as follows:
 - 1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.
 - 2. Mechanically clinch or button punch.
 - 3. Fasten with a minimum of 1-1/2-inch- (38-mm-) long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:
 - 1. End Joints: Lapped.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure in accordance with SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, in accordance with SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.4 REPAIR

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

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:

1. Special inspections and qualification of welding special inspectors for cold-formed steel floor deck in accordance with quality-assurance inspection requirements of SDI QA/QC.
 - a. Field welds will be subject to inspection.
 2. Steel decking will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 05 31 00

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Load-bearing wall framing.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cold-formed steel framing materials.
 - 2. Load-bearing wall framing.
 - 3. Power-actuated anchors.
- 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.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Product Certificates: For each type of code-compliance certification for studs and tracks.
- C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency.
 - 1. Steel sheet.
 - 2. Power-actuated anchors.

3. Mechanical fasteners.
4. Miscellaneous structural clips and accessories.

D. Research Reports:

1. For nonstandard cold-formed steel framing and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 COLD-FORMED STEEL FRAMING MATERIALS

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
 1. Grade: ST33H (ST230H) or ST50H (ST340H), as indicated.
 2. Coating: G90 (Z275) or equivalent.

2.2 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 (1.09 mm).
 2. Flange Width: 2 inches (51 mm).
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
 1. Minimum Base-Metal Thickness: Matching steel studs.
 2. Flange Width: 1-1/4 inches (32 mm).
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
 1. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).

2. Flange Width: 2 inches (51 mm).

2.3 FRAMING ACCESSORIES

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
 1. Supplementary framing.
 2. Bracing, bridging, and solid blocking.
 3. Web stiffeners.
 4. Anchor clips.
 5. End clips.
 6. Stud kickers and knee braces.
 7. Hole-reinforcing plates.
 8. Backer plates.

2.4 ANCHORS, CLIPS, AND FASTENERS

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
- B. Power-Actuated Anchors: Power-actuated anchors shall be HILTI X-U Universal High-Performance Fasteners or an approved equivalent with accompanying evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- C. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.

2.5 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: ASTM A780/A780M.
- B. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- C. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.

2.6 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 screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
 - a. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
1. Spacing: Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
 2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of concrete slab at locations with a gap larger than 1/4 inch (6 mm) to ensure a uniform bearing surface on supporting concrete construction.

3.3 INSTALLATION, GENERAL

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw or bolt wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch (1.6 mm).
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
 1. Cut framing members by sawing or shearing; do not torch cut.
 2. Fasten cold-formed steel framing members by screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
 - a. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

3.4 INSTALLATION OF LOAD-BEARING WALL FRAMING

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
 1. Anchor Spacing: To match stud spacing.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch (3 mm) between the end of wall-framing member and the web of track.
 1. Fasten both flanges of studs to top and bottom tracks.
 2. Space studs as follows:
 - a. Stud Spacing: 16 inches (406 mm).
- C. Set studs plumb.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Anchor studs abutting structural walls, including concrete walls, to supporting structure.

- F. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
 - 1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
 - 2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles, and space jack studs same as full-height wall studs.
- G. Install horizontal bridging in stud system, spaced vertically 48 inches (1220 mm). Fasten at each stud intersection.
 - 1. Channel Bridging: Cold-rolled steel channel, mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches (150 mm) deep.
 - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
 - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- H. Install steel sheet diagonal bracing straps to both stud flanges; terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.
- I. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

3.5 INSTALLATION TOLERANCES

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:
 - 1. Space individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.6 REPAIR

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

- B. Testing agency will report test results promptly and in writing to Contractor and Architect.
- C. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 40 00

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Metal ladders.

B. Related Requirements:

1. Section 05 12 00 "Structural Steel Framing" for steel framing, supports, and other steel items attached to the structural-steel framing.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Fasteners.
2. Manufactured metal ladders.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections.
2. Metal ladders.

C. Delegated Design Submittals: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Mill Certificates: Signed by steel manufacturers, certifying that products furnished comply with requirements.
2. Welding certificates.

B. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design ladders.
- B. Structural Performance of Ladders: Ladders are to withstand the effects of loads and stresses within limits and under conditions specified in ANSI/ASC A14.3.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

2.3 FASTENERS

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325 (Grade A325M), Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, (ASTM A563M, Class 10S3) heavy-hex carbon-steel nuts; and where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. Coordinate anchorage with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

- C. Galvanize miscellaneous framing and supports where indicated.

2.7 METAL LADDERS

- A. General:

- 1. Comply with ANSI A14.3.

- B. Steel Ladders:

- 1. Space siderails 18 inches (457 mm) apart unless otherwise indicated.
 - 2. Siderails: Continuous, 3/8-by-2-1/2-inch (9.5-by-64-mm) steel flat bars, with eased edges.
 - 3. Rungs: 3/4-inch- (19-mm-) diameter, steel bars.
 - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 - 5. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
 - 6. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
 - 7. Support each ladder at top and bottom and not more than 60 inches (1500 mm) o.c. with welded or bolted steel brackets.
 - 8. Galvanize exterior ladders, including brackets.

2.8 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.

- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.9 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel hardware and with ASTM A123/A123M for other steel products.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.3 INSTALLATION OF METAL LADDERS

- A. Secure ladders to adjacent construction with the clip angles attached to the stringer.
- B. Install brackets as required for securing of ladders welded or bolted to structural steel.

3.4 REPAIRS

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 50 00

SECTION 05 51 19 - METAL GRATING STAIRS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal grating stairs.
 - 2. Steel railings and guards.

1.2 COORDINATION

- A. Coordinate installation of anchorages for metal stairs, railings, and guards.
 - 1. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

- A. Product Data: For metal grating stairs and the following:
 - 1. Gratings.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details, and attachment to other work.
 - 2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
 - 3. Include plan at each level.
- C. Delegated Design Submittal: For stairs, railings, and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification.
1. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.
 2. Protect steel members and packaged materials from corrosion and deterioration.
 3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
 - a. Repair or replace damaged materials or structures as directed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design stairs, railings, and guards, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
 2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
 3. Uniform and concentrated loads need not be assumed to act concurrently.
 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 5. Limit deflection of treads, platforms, and framing members to $L/360$.
- C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 2. Infill of Guards:
 - a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.

3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 METALS

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- D. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- E. Steel Wire Rod for Grating Crossbars: ASTM A510/A510M.
- F. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed) or ASTM A513/A513M.
 1. Provide galvanized finish for exterior installations and where indicated.
- G. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- H. Provide galvanized finish for exterior installations and where indicated.
- I. Cast-Abrasive Nosings: Cast iron, with an integral abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both.

2.3 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use.
 1. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563 (ASTM A563M); and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.

- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780/A780M and compatible with paints specified to be used over it.

2.5 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
 - 5. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that are exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.6 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Fabricate stringers of steel plates or channels.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article.
 - b. Provide closures for exposed ends of channel stringers.
 - c. Finish: Galvanized.
 - 2. Construct platforms and tread supports of steel plate or channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel framing.
 - b. Finish: Galvanized.
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."
 - 1. Fabricate treads and platforms from welded steel grating with 1-1/4-by-3/16-inch (32-by-5-mm) bearing bars at 15/16 inch (24 mm) o.c. and crossbars at 4 inches (100 mm) o.c.
 - 2. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 1 inch (25 mm) in least dimension.
 - a. Surface: Serrated.
 - b. Finish: Galvanized.
 - 3. Fabricate grating treads with cast-abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections.
 - a. Secure treads to stringers with bolts.
 - 4. Fabricate grating platforms with nosing matching that on grating treads.
 - a. Secure grating to platform framing by welding or with bolts.
- D. Risers: Open.

2.7 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.

1. Rails and Posts: 1-5/8-inch- (41-mm-) diameter top and bottom rails and 1-1/2-inch- (38-mm-) square posts.
 2. Intermediate Rails Infill: 1-5/8-inch- (41-mm-) diameter intermediate rails spaced less than 21 inches (533 mm) clear.
- B. Welded Connections: Fabricate railings and guards with welded connections.
1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 3. Weld all around at connections, including at fittings.
 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 5. Obtain fusion without undercut or overlap.
 6. Remove flux immediately.
 7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter as shown in NAAMM AMP 521.
- C. Form changes in direction of railings and guards as follows:
1. By bending or by inserting prefabricated elbow fittings.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.
1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing and guard members with prefabricated end fittings.
- F. Connect posts to stair framing by direct welding unless otherwise indicated.
- 2.8 FINISHES
- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
1. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF METAL STAIRS

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- B. Install metal stairs by welding stair framing to steel structure unless otherwise indicated.
- C. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 - 3. Comply with requirements for welding in "Fabrication, General" Article.

3.3 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 - 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 - 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
 - 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by welding or bolting to steel supporting members.

3.4 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 51 19

SECTION 05 53 13 - BAR GRATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal bar gratings.

B. Related Requirements:

1. Section 05 12 00 "Structural Steel Framing" for structural-steel framing system components.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Clips and anchorage devices for gratings.

B. Shop Drawings:

1. Include plans, sections, and attachment details.
2. Signed and sealed by the qualified professional engineer responsible for their preparation.

C. Delegated Design Submittals: For gratings, including manufacturers' published load tables.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Furnish setting drawings, templates, and directions for installing anchorages.

B. Certificates:

1. Welding certificates.

C. Delegated design engineer qualifications.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Delegated Design Engineer: A professional engineer who is legally qualified to practice in the District of Columbia where Project is located and who is experienced in providing engineering services of the type indicated.
2. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:
 - a. AWS D1.1/D1.1M.

1.5 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design gratings.
- B. Structural Performance: Gratings to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Catwalks and Elevated Platforms Other Than Exits: Uniform load of 40 lbf/sq. ft. (2.87 kN/sq. m).

2.2 METAL BAR GRATINGS

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531.
 1. Bearing Bar Spacing: 1-3/16 inches (30 mm) o.c.
 2. Bearing Bar Depth: 1-1/2 inches (38 mm).
 3. Bearing Bar Thickness: 3/16 inch (4.8 mm).
 4. Crossbar Spacing: 4 inches (102 mm) o.c.
 5. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A (ISO 898-1, Property Class 4.6); with hex nuts, ASTM A563 (ASTM A563M), and, where indicated, flat washers.

2.4 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

2.5 FERROUS METALS

- A. Steel Bars for Bar Gratings: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- B. Wire Rod for Bar Grating Crossbars: ASTM A510/A510M.

2.6 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
- G. Do not notch bearing bars at supports to maintain elevation.

2.7 STEEL FINISHES

- A. Finish gratings, frames, and supports after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Fit exposed connections accurately together to form hairline joints.
 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- D. Field Welding: Comply with AWS recommendations and the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.

3.2 INSTALLATION OF METAL BAR GRATINGS

- A. Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 REPAIR

- A. Repair of Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 05 53 13

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concealed wood blocking, nailers, and supports.

1.2 RELATED REQUIREMENTS

- A. Section 09 2116 - Gypsum Board Assemblies: Gypsum-based sheathing.

1.3 REFERENCE STANDARDS

- A. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing; 2003 (Reapproved 2017).
- B. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- C. ICC (IBC) - International Building Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. PS 20 - American Softwood Lumber Standard; 2015.

1.4 SUBMITTALS

- A. Product Data: Provide technical data on wood preservative materials and application instructions.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
 - 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.

2.2 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Sizes: Nominal sizes as indicated on drawings, S4S.
- B. Moisture Content: S-dry or MC19.
- C. Stud Framing (2 by 2 through 2 by 6):
 - 1. Species: Any allowed under referenced grading rules.
 - 2. Grade: No. 2.
- D. Miscellaneous Framing, Blocking and Nailers:
 - 1. Lumber: S4S, No. 2 or Standard Grade.
 - 2. Boards: Standard or No. 3.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.2 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.

3.3 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. Provide the following specific non-structural framing and blocking:
 - 1. Cabinets and shelf supports.
 - 2. Wall brackets.
 - 3. Handrails.
 - 4. Grab bars.
 - 5. Towel and bath accessories.

3.4 CLEANING

- A. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

- B. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 06 1000

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Specially fabricated birch solid wood cabinet units.
- B. Hardware.
- C. Factory finishing.

1.2 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 066100 - Simulated Stone Fabrications: Cast plastic countertops.

1.3 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2014, with Errata (2018).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards, U.S. Version 3.1; 2016, with Errata (2018).
- C. BHMA A156.9 - American National Standard for Cabinet Hardware; 2015.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
- B. Product Data: Provide data for hardware accessories. Match campus standards.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five 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 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.
5. Replace, repair, or rework all work for which certification is refused.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage. Units are to be fully secured and protected throughout all logistic transport movement, from the fabrication shop to the site.

1.7 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy for at least 72 hours prior to installation.

PART 2 PRODUCTS

2.1 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Cabinets:
 1. Finish - Exposed Exterior Surfaces: Wood.
 2. Finish - Exposed Interior Surfaces: Wood.
 3. Finish - Concealed Surfaces: Wood.
 4. Door and Drawer Front Edge Profiles: solid wood radius edge.
 5. Door and Drawer Front Retention Profiles: Fixed panel.
 6. Casework Construction Type: Type A - Frameless. All Casework components shall be solid wood, plywood and high-density particle board are not permitted
 7. Interface Style for Cabinet and Door: Style 2 - Finish Inset; reveal overlay.

2.2 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.3 COUNTERTOPS

- A. Solid Surface. Specified in Section 066100.

2.4 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
- C. Fasteners: Size and type to suit application.
- D. 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.
- E. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.5 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, polished chrome finish, for nominal 1 inch spacing adjustments.
- C. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers ("U" shaped wire pull, steel with chrome finish, 100 mm centers). Knob hardware is not allowed.
- D. Catches: Magnetic.
- E. Cabinet Locks: Keyed cylinder, two keys per lock, master keyed, steel with chrome finish.
- F. Drawer Slides:
 - 1. Type: Extension types as required.
 - 2. Static Load Capacity: Commercial grade.
 - 3. Mounting: Side mounted.
 - 4. Features: Provide self closing/stay closed type.
- G. Hinges: European style concealed self-closing/slow closing type, steel with polished finish.

2.6 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 to fill any/all gaps or left over space.

- D. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

2.7 SHOP FINISHING

- 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 - 1, Lacquer, Nitrocellulose.
 - b. Sheen: Semigloss.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level to a degree of 1/8" per 8'-0".
- B. Secure cabinets to floor using appropriate angles and anchorages.

3.3 ADJUSTING

- A. Protect installed work until all construction work is substantially completed. Owner reserves the right to have damaged product at the time of punch-list, fully torn out and replaced if suitable in place repair of the damaged product cannot be employed.
- B. Adjust installed work.

3.4 CLEANING

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

END OF SECTION 06 4100

SECTION 06 61 00 - SIMULATED STONE FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cast plastic counter top and window sills.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate dimensions, thicknesses, required clearances, tolerances, materials, colors, finishes, fabrication details, field jointing, adjacent construction, design load parameters, methods of support, integration of plumbing components, and anchorages.
- B. Samples: Submit two samples representative of counter top, 4 x 4 inch in size, illustrating color, texture, and finish.
- C. Manufacturer's Installation Instructions: Indicate preparation of opening required, rough-in sizes; tolerances for item placement, temporary bracing of components.
- D. Maintenance Data: Indicate list of approved cleaning materials and procedures required; list of substances that are harmful to the component materials.
- E. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.3 QUALITY ASSURANCE

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

1.4 WARRANTY

- A. Correct defective Work within a five year period after Date of Substantial Completion.
- B. Provide 10 year manufacturer warranty for defects in manufacturer shape, finish, and color.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cast Plastic Fabrications:
 - 1. Avonite; Product Avonite.
 - 2. E.I. Dupont de Neours & Co. Inc.; Product Corian.

3. Wilsonart International, Inc.; Product Gibraltar.
4. Formica Corporation.

2.2 MATERIALS

- A. Resin: Polyester type, with integral coloring, stain resistant to domestic chemicals and cleaners.

2.3 FABRICATION

- A. Fabricate components by mold to achieve shape and configuration.
- B. Radius corners and edges.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that joint preparation and affected dimensions are acceptable.

END OF SECTION 06 61 00

SECTION 07 21 00 - THERMAL INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Batt insulation in wall construction.
- B. Batt insulation for filling around doors.

1.2 RELATED REQUIREMENTS

- A. Section 09 2116 - Gypsum Board Assemblies: Acoustic insulation inside walls and partitions.

1.3 REFERENCE STANDARDS

- A. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2017.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018b.
- C. ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace At 750 Degrees C; 2016a.

1.4 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- B. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.2 BATT INSULATION MATERIALS

- A. Where batt insulation is indicated, either glass fiber or mineral fiber batt insulation may be used, at Contractor's option.

- B. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.
 - 1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
- C. Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.
 - 1. Smoke Developed Index: 0 (zero), when tested in accordance with ASTM E84.

PART 3 EXECUTION

3.1 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.

3.2 BATT INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Install in wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Verify that the insulation material show no signs of mold/mildew growth. Discard any insulation that shows signs of mildew or discoloration from mildew.
- E. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.3 PROTECTION

- A. Insulation is not permitted to be an exposed finish material and should not be left permanently exposed to any occupied space. any/all insulation must be permanently enclosed or concealed with a proper finished assembly material per U.L. standard.
- B. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 07 21 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof curbs.
- B. Equipment rails.
- C. Roof penetrations mounting curbs.

1.2 SUBMITTALS

- A. 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.
- B. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
- C. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS

2.1 ROOF CURBS

- A. 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.
- B. Roof Curb Mounting Substrate: Curb substrate consists of flat roof deck sheathing with insulation.
 - 1. Sheet Metal Material: Aluminum: 0.080 inch minimum thickness, with 3003 alloy, and H14 temper.
 - 2. 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.
 - 3. Fabricate curb bottom and mounting flanges for installation directly on metal roof panel system to match slope and configuration of system.
 - 4. Extend side flange to next adjacent roof panel seam and comply with seam configurations and seal connection, providing at least 6 inch clearance between curb

- and metal roof panel flange allowing water to properly flow past curb.
5. Where side of curb aligns with metal roof panel flange, attach fasteners on upper slope of flange to curb connection allowing water to flow past below fasteners, and seal connection.
 6. Maintain at least 12 inch clearance from curb, and lap upper curb flange on underside of down sloping metal roof panel, and seal connection.
 7. Lap lower curb flange overtop of down sloping metal roof panel and seal connection.
 8. Provide layouts and configurations indicated on drawings.

C. Curbs Adjacent to Roof Openings:

1. Provide curb on each side of opening, with top of curb horizontal for equipment mounting.
2. Provide preservative treated wood nailers along top of curb.
3. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
4. 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. Provide preservative treated wood nailers along top of rails.
2. Height Above Finished Roof Surface: 12 inches, minimum.

E. Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches square unless otherwise indicated.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.

3.2 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.

3.3 INSTALLATION

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

END OF SECTION 07 72 00

SECTION 07 84 00 – FIRESTOPPING

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 09 2116 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.3 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2018c.
- 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.
- D. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestops; 2018.
- E. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2015b, with Editorial Revision (2016).
- F. 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).
- G. ITS (DIR) - Directory of Listed Products; current edition.
- H. FM (AG) - FM Approval Guide; current edition.
- I. UL 1479 - Standard for Fire Tests of Penetration Firestops; Current Edition, Including All Revisions.
- J. UL (FRD) - Fire Resistance Directory; Current Edition.

1.4 SUBMITTALS

- A. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
- B. Product Data: Provide data on product characteristics, performance ratings, and limitations.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Certificate from Authority Having Jurisdiction indicating approval of materials used.
- F. Installer Qualification: Submit qualification statements for installing mechanics.

1.5 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. Installer Qualifications: Company specializing in performing the work of this section and:

1.6 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

2.1 MANUFACTURERS

- A. Firestopping Manufacturers:
 - 1. 3M Fire Protection Products: www.3m.com/firestop/#sle.
 - 2. Hilti, Inc: www.us.hilti.com/#sle.
 - 3. Nelson FireStop Products: www.nelsonfirestop.com/#sle.
 - 4. Specified Technologies Inc: www.stifirestop.com/#sle.
 - 5. Owner approved substitutions.

2.2 MATERIALS

- A. Firestopping Materials: Any materials meeting requirements.
- B. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Provide type of materials as required for tested firestopping assembly.

2.3 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 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 floor or wall, whichever is greater.
- C. 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.

2.4 FIRESTOPPING SYSTEMS

- A. Firestopping: Any material meeting requirements.
 - 1. Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.2 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.

3.3 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 authorities having jurisdiction.

- C. Install labeling required by code.

3.4 FIELD QUALITY CONTROL

- A. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.5 3.5 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.6 3.6 PROTECTION

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

END OF SECTION 07 84 00

SECTION 07 92 00 - JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping: Firestopping sealants.

1.3 REFERENCE STANDARDS

- A. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants; 2018.
- B. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.
- C. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2016.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

1.4 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. Preconstruction Laboratory Test Reports: Submit at least four weeks prior to start of installation.

1.5 QUALITY ASSURANCE

- A. 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.

1.6 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

2.1 MANUFACTURERS

- A. Non-Sag Sealants: Permits application in joints on vertical surfaces without sagging or slumping.

2.2 JOINT SEALANT APPLICATIONS

- A. Scope:
 1. 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. Other joints indicated below.
 2. 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. Interior Joints: Type S-Use non-sag polyurethane sealant, unless otherwise indicated.
 1. Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.
 2. Narrow Control Joints in Interior Concrete Slabs: Self-leveling polyurethane sealant.
 3. Sealants in the Clean Room areas shall be supplied by the Clean Room manufacturer.
 4. Other Floor Joints: Self-leveling polyurethane "traffic-grade" sealant.

2.3 NONSAG JOINT SEALANTS

- A. Type S - Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
 - 1. Color: White.
- B. Type S - Polyurethane Sealant: ASTM C920, Grade NS, Uses M and A; single or multi-component; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 12.5 percent, minimum.

2.4 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.
- 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.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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. Install bond breaker backing tape where backer rod cannot be used.
- D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- E. 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.
- F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.4 FIELD QUALITY CONTROL

- A. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION 07 92 00

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Fire-rated hollow metal doors and frames.
- C. Accessories, including glazing and louvers.

1.2 RELATED REQUIREMENTS

- A. Section 08 7100 - Door Hardware.
- B. Section 08 8000 - Glazing: Glass for doors and borrowed lites.
- C. Section 09 9123 - Interior Painting: Field painting.

1.3 ABBREVIATIONS AND ACRONYMS

- A. ANSI: American National Standards Institute.
- B. SDI: Steel Door Institute.
- C. UL: Underwriters Laboratories.

1.4 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 A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames; 2003 (R2009).
- D. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2017.
- E. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2011.
- F. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2018a.

- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2019a.
- H. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2018.
- 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. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2016.
- K. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- L. ITS (DIR) - Directory of Listed Products; current edition.
- M. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- N. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2011.
- O. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; 2007.
- P. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- Q. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2019.
- R. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2017.
- 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.

1.5 SUBMITTALS

- A. 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.
- B. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and any indicated finish requirements.
- C. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.
- D. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: www.steeldoor.org/sdicertified.php/#sle.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.7 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

2.1 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
 - 1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 - 3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 - 4. Steelcraft, an Allegion brand: www.allegion.com/#sle.
 - 5. Owner approved substitutions.

2.2 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: Manufacturers standard.
 - 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.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for

instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.3 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Interior Doors, Non-Fire-Rated:
 - 1. Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
 - a. Level 1 - Standard-duty.
 - b. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - c. Model 1 - Full Flush.
 - d. Door Face Metal Thickness: 20 gage, 0.032 inch, minimum.
 - 2. Door Thickness: 1-3/4 inch, nominal.
 - 3. Door Face Sheets: Flush.
 - 4. Top Closures for Doors: Flush with top of faces and edges.
 - 5. Door Finish: Factory primed and field finished.
- C. Fire-Rated Doors:
 - 1. Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
 - 2. Provide units listed and labeled by UL (DIR) or ITS (DIR).
 - a. Attach fire rating label to each fire rated unit.
 - 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.

2.4 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Frame Finish: Factory primed and field finished.
- C. Exterior Door Frames: Knock-down type.
 - 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 - 2. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
 - 3. Weatherstripping: Separate, see Section 08 7100.

- D. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Frame Metal Thickness: 18 gage, 0.042 inch, minimum.
- E. Door Frames, Fire-Rated: Knock-down type.
 - 1. Fire Rating: Same as door, labeled.
- F. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
- G. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.

2.5 FINISHES

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

2.6 ACCESSORIES

- A. Louvers: Roll formed steel with overlapping frame; finish same as door components; factory-installed.
 - 1. In Fire-Rated Doors: UL (DIR) or ITS (DIR) listed fusible link louver, same rating as door.
- B. Door Window Frames: Door window frames with glazing securely fastened within door opening.
 - 1. Size: As indicated on drawings.
- C. Glazing: As specified in Section 08 8000, factory installed.
- D. Removable Stops: Formed sheet steel, shape as indicated on drawings, mitered or butted corners; prepared for countersink style tamper proof screws.
- E. Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify door and frame are not damaged. Do not install if manuf. defects are apparent or visible.

- D. Verify that finished walls are in plane to ensure proper door alignment.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Install fire rated units in accordance with NFPA 80.
- C. Coordinate frame anchor placement with wall construction.
- D. Install door hardware as specified in Section 08 7100.
- E. Comply with glazing installation requirements of Section 08 8000.
- F. Coordinate installation of electrical connections to electrical hardware items.
- G. Touch up damaged factory finishes. Fire rated labels must be kept clearly visible. Temporary protect labels before field painting.

3.4 TOLERANCES

- A. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.5 ADJUSTING

- A. Adjust for smooth and balanced door movement.

END OF SECTION 08 11 13

SECTION 08 11 14 – STAINLESS STEEL DOORS AND FRAMES
(Model 220SS EXCEL SINGLE SWINGING STAINLESS STEEL DOOR SYSTEM)

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Manually operated Single Swinging Stainless Steel Door Systems and accessories for complete installation.

1.2 RELATED SECTIONS

- A. Division 26 – Electrical.

1.3 SUBMITTALS

- A. Product Data: Completely describing components.
- B. Shop Drawings: Showing details of fabrication, installation and accommodation to connecting work.
- C. Installation Instructions: For door, and accessories.
- D. Operating and Maintenance Data: For door, and accessories.

1.4 QUALITY ASSURANCE

- A. Installer Qualification: Door manufacturer, or trained, approved and licensed door installer.

PART 2 PRODUCT

2.1 MANUFACTURERS

- A. Model 220SS manually operated Single Swinging Stainless Steel Door System as manufactured by ASI Doors, Inc., Milwaukee, WI.
- B. Substitutions:
 - 1. No substitution will be considered unless written request for approval has been submitted by the bidder and has been received by the architect at least ten (10) days prior to the date for receipt of bids.
 - 2. Each such request shall include the name of the materials for which it is to be substituted and a complete description of the proposed substitute, including drawings, cuts, mockups, performance and test data, a list of projects of similar scope and photographs of existing installations, and any other information necessary for evaluation.

2.2 SINGLE SWINGING STAINLESS STEEL DOORS

A. Model 220SS Excel Swinging Stainless Steel Door System.

1. Door size to fit door opening as shown on architectural drawings.
2. Door shall be Manual Single Swinging Stainless Steel Cleanroom Door System.
3. Door panel shall be made of 16 gauge type 304, #4 stainless steel. Panel shall have INVISIBLE EDGE SEAMS continuously welded, ground smooth, refinished, and repolished on all four sides and corners of panel. All hardware reinforcements to be minimum 12 gauge steel. Door bevel shall be 1/8" bevel on 2".
4. Door shall have a styrene core laminated to both face skins.
5. Stainless steel door frames shall be 16 gauge 304, #4 finish with industry standard 2" face with variable profile. Frames shall be continuously welded units. Corner joints shall have all contact edges closed tight. Faces to be mitered, welded, ground smooth and polished.
6. Standard hardware to include: stainless steel butt hinges, applied with stainless steel fasteners; and a push/pull hardware set constructed of stainless steel. (Hardware to be manufacturers standard unless otherwise specified.)
7. Stainless closers with aluminum finish. (Optional stainless steel covers available.) Closers to manual open and spring close.
8. Full perimeter gasketing on three sides of the frame and a bottom sill gasket face mounted on the bottom of the door panel.
9. Vision panel option will include two 45 degree sloped stainless steel frames connected internally with no exposed fasteners on either side of the door panel. (Flush glass available as an option.) Also include factory installed 1/4" tempered glass.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes your acceptance of conditions as satisfactory.
1. Verify opening size, dimensions and tolerances.

3.2 PREPARATION

- A. Protect surrounding areas and surfaces to prevent damage during work of this section.

3.3 3.3 INSTALLATION

- A. Install the work in accordance with manufacturer instructions.

3.4 WARRANTIES

- A. Two year limited warranty on all components.

3.5 CLEANING

- A. Leave the premises clean and free of residue of work of this section.

END OF SECTION 08 11 14

SECTION 08 31 00 - ACCESS DOORS AND PANELS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall access door and frame units.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate exact position of all access door units.

PART 2 PRODUCTS

2.1 ACCESS DOOR AND PANEL APPLICATIONS

- A. Walls, Unless Otherwise Indicated:
 - 1. Size: as required for item being accessed inch, unless otherwise indicated.
 - 2. Tool-operated spring or cam lock; no handle.
 - 3. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
- B. Fire Rated Ceilings: See drawings for ceiling fire ratings.
 - 1. Material: Steel.
 - 2. Size: 24 by 24 inch, unless otherwise indicated.

2.2 WALL AND CEILING UNITS

- A. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies that units are to be installed in.
 - 1. Door Style: Single thickness with rolled or turned in edges.
 - 2. Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly that access doors are being installed.
 - 3. Steel Finish: Primed.
 - 4. Primed and Factory Finish: Polyester powder coat; color to be selected by Senior Mechanical Facility Engineer.
 - 5. Hardware:
 - a. Hardware for Fire Rated Units: As required for listing.
 - b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.

2.3 FLOOR UNITS

- A. Floor Door and Frame Units: Factory fabricated, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.
 - 1. Size: As indicated on the drawings.
 - 2. Hardware: Steel, hot-dipped galvanized.
 - a. Hinges: Removable pin.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Install frames plumb and level in openings. Secure rigidly in place.
- C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION 08 31 00

SECTION 08 33 23 - OVERHEAD COILING DOORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Overhead coiling doors, operating hardware, non-fire-rated; manually or electrically operated.

1.2 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 26 0529 - Raceways and Boxes for Electrical Systems.
- C. Section 28 3111 - Digital Addressable Fire Alarm System.

1.3 REFERENCE STANDARDS

- A. ITS (DIR) - Directory of Listed Products; current edition.
- B. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2019.
- C. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2016.
- D. UL (DIR) - Online Certifications Directory; Current Edition.
- E. UL 1784 - Standard for Air Leakage Tests of Door Assemblies; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
- B. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
- C. Provide manufacturers standard warranty.
- D. Maintenance Data: Indicate lubrication requirements and frequency and periodic adjustments required.

1.5 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

2.1 MANUFACTURERS

- A. Overhead Coiling Doors:
 - 1. Clopay Building Products: www.clopaydoor.com/#sle.
 - 2. Cornell Iron Works, Inc: www.cornelliron.com/#sle.
 - 3. The Cookson Company: www.cooksondoor.com/#sle.
 - 4. Wayne-Dalton, a Division of Overhead Door Corporation: www.wayne-dalton.com/#sle.
 - 5. Owner approved substitutions.
- B. Overhead Coiling Fabric Doors:
 - 1. Refer to door schedule for fabric rollup door manufacturer.
 - 2. Owner approved substitutions.

2.2 COILING DOORS

- A. Coiling Doors: Steel slat curtain.
 - 1. Provide products listed and labeled by ITS (DIR) or UL (DIR) as suitable for purpose specified and indicated on drawings.
 - 2. Oversized Openings: Provide certificate of compliance from authorities having jurisdiction indicating approval of fire rated units and operating hardware assembly.
 - 3. Finish: Factory painted, color as selected.
 - 4. Hood Enclosure: Manufacturer's standard; primed steel.
 - 5. Coiling Door Release Mechanism: Fire alarm system activated with automatically governed closing speed.
 - 6. Manual hand chain lift operation.

2.3 MATERIALS AND COMPONENTS

- A. Curtain Construction: Interlocking slats.
 - 1. Slat Ends: Alternate slats 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. Smoke Seals: Provide brush or gasket type weatherstripping seals to prevent passage of smoke and hot gases in compliance with UL 1784 testing requirements.
- B. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

- C. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.
- D. 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.
- E. Provide one full set of spare parts to the owner.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that opening sizes, tolerances and conditions are acceptable.

3.2 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. Complete wiring from fire alarm system.
- F. Install enclosure and perimeter trim.
- G. Labels for fire rated doors must be kept clearly visible. Protect during field painting.

3.3 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.

3.4 ADJUSTING

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

3.5 CLEANING

- A. Clean installed components.
- B. Remove labels (except fire rateding labels) and visible markings.

END OF SECTION 08 33 23

SECTION 08 33 24 - RAPID ROLL-UP DOORS
MODEL 415 ISO-ROLL HIGH SPEED FABRIC ROLL-UP DOOR SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fabric Roll-Up doors and accessories for complete installation.

1.2 RELATED SECTIONS

- A. Division 26 - Electrical

1.3 SUBMITTALS

- A. Product Data: Completely describing components.
- B. Shop Drawings: Showing details of fabrication, installation and accommodation to connecting work.
- C. Installation Instructions: For door, operator and accessories.
- D. Operating and Maintenance Data: For door, operator and accessories.

1.4 QUALITY ASSURANCE

- A. Installer Qualification: Door manufacturer, or trained, approved and licensed door installer.

PART 2 PRODUCT

2.1 MANUFACTURERS

- A. Model 415 Iso-Roll Fabric Roll-Up Door System as manufactured by ASI Doors, Inc., Milwaukee, WI.
- B. Substitutions:
 - 1. No substitution will be considered unless written request for approval has been submitted by the bidder and has been received by the architect at least ten (10) days prior to the date for receipt of bids.
 - 2. Each such request shall include the name of the materials for which it is to be substituted and a complete description of the proposed substitute, including drawings, cuts, mockups, performance and test data, a list of projects of similar scope and photographs of existing installations, and any other information necessary for evaluation.

2.2 FABRIC ROLL-UP DOORS

A. Model 415 Iso-Roll High Speed Fabric Roll-Up Door System.

1. Door size to fit door opening shown on architectural drawings.
2. Doors shall be high speed electric powered fabric roll-up doors.
3. Fabric to be a minimum .030" thick polyester multifilament PVC coated curtain material, FDA compliant. Panel color to be white or blue.
4. Electric operator to allow open speed up to 50 inches per second. Electric motor to be 1 hp, 120 volt, single phase or optional 230/460 volts, 3 phase 60 hz unit. Two speed operation 48"/sec. open, 21"/sec. close. Self-diagnostic custom microprocessor with variable frequency motor drive allows for speed to be fully adjustable.
5. Electric control panel to be in a NEMA-4 rated enclosure, assembled and ready for connection by others. Control panel must have push button emergency stop.
6. Curtain bottom edge to be free of any rigid structural pieces. Bottom edge equipped with a flexible wireless reversing edge. Reversing edge to be sealed within the full width of the bottom curtain loop and is activated only when pressure is applied. Reversing signal sent wirelessly via transmitter and receiver eliminating coil cords. Wires on the bottom edge or sides of curtain will not be allowed; coil cords are also not allowed.
7. Send and receive photo eye to be provided, located within door side frame.
8. Absolute encoder to provide infinite adjustment. Adjustments to be made without the aid of special tools. NO DOOR TRAVEL SETTINGS NEED TO BE RESET AFTER POWER LOSS. Doors requiring manual assistance, recalibration, or operator interface with door controls after power loss are not allowed.
9. Door actuation to be provided by:
 - a. Standard double gang, flush mount push plates with "PRESS TO OPERATE DOOR" legend and stainless steel surround
 - b. Single control with Open / Close and Emergency Stop push buttons.
 - c. or options:
 - d. One ceiling mounted, low voltage pull switch.
 - e. or
 - f. Radio control actuator.
 - g. or
 - h. Motion detector system.
10. Curtain displacement and recapture system:
 - a. Door curtain shall be able to release at any point of the full height on both edges of door.
 - b. Door curtains that partially release are not acceptable.
 - c. Impacted or displaced curtain will automatically recapture itself on the next upward cycle. Doors requiring manual assistance, recalibration, or operator interface with door controls for curtain alignment are not allowed.
 - d. Doors requiring straps, breakable clips, tape connections, or wind knobs or wheels on the curtain will not be allowed.
11. Springs or counterweights in barrels and/or side columns will not be allowed. Tension straps will not be allowed.
12. Curtain & Track Retention System:

- a. Door curtain to be free of any rigid or structural stiffeners and bottom bars.
 - b. Door curtain top seal integrated to door curtain. Top seal rolls up with door to prevent scraping of vision window and curtain discoloration. Seal to automatically deploy against wall when door is fully closed. Door curtains with top seal penetrating wall or constant contact while door rolls up are not allowed.
 - c. Top to bottom continuous side seals. Curtain edges to have continuous lateral reinforced strips from floor to top of opening eliminating potential of gaps for air infiltration. Door curtain will fully retract under/into door shroud in full open position.
 - d. Continuous track system to require no more than 4mm gap for door curtain edges to travel inside of. Track retention system capable to holding pressure up to .12 inches of water column. Track Systems requiring additional gasket attached to side frames are not acceptable.
 - e. Low profile side column requires 3 1/8" wall space on each side of door opening.
 - f. Doors requiring straps, breakable clips, tape connections, wheels or wind knobs on the curtain or breakaway feature will not be allowed.
- 13. Provide a minimum 12 gauge 304 stainless steel side guide/frame system. Side covers minimum 20 gauge, 304 stainless steel.
 - 14. Provide minimum 16 gauge 304 stainless steel shroud to cover barrel and operator mechanism.
 - 15. Full width 28" high clear PVC window panel is optional.
 - a. Window to have beveled top and bottom edges.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify installation conditions as satisfactory to receive work of this section. Do not install until unsatisfactory conditions are corrected. Beginning work constitutes your acceptance of conditions as satisfactory.
 - 1. Verify opening size, dimensions and tolerances.

3.2 PREPARATION

- A. Protect surrounding areas and surfaces to prevent damage during work of this section.

3.3 INSTALLATION

- A. Install the work in accordance with manufacturer instructions.

3.4 WARRANTIES

- A. One year limited warranty on all components.

3.5 CLEANING

- A. Leave the premises clean and free of residue of work of this section.

END OF SECTION 08 33 24

SECTION 08 71 00 - DOOR HARDWARE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hardware for hollow metal doors.
- B. Hardware for fire-rated doors.
- C. Electrically operated and controlled hardware.
- D. Weatherstripping and gasketing.

1.2 RELATED REQUIREMENTS

- A. Section 08 1113 - Hollow Metal Doors and Frames.
- B. Section 08 3323 - Overhead Coiling Doors: Door hardware, except cylinders.
- C. Section 28 1000 - Access Control: Electronic access control devices.

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. BHMA A156.1 - American National Standard for Butts and Hinges; 2016.
- C. BHMA A156.2 - American National Standard for Bored and Preamsembled Locks & Latches; 2017.
- D. BHMA A156.3 - American National Standard for Exit Devices; 2014.
- E. BHMA A156.4 - American National Standard for Door Controls - Closers; 2013.
- F. BHMA A156.6 - American National Standard for Architectural Door Trim; 2015.
- G. BHMA A156.12 - American National Standard for Interconnected Locks; 2013.
- H. BHMA A156.13 - American National Standard for Mortise Locks & Latches Series 1000; 2017.
- I. BHMA A156.16 - American National Standard for Auxiliary Hardware; 2018.
- J. BHMA A156.18 - American National Standard for Materials and Finishes; 2016.
- K. BHMA A156.22 - American National Standard for Door Gasketing and Edge Seal Systems Sponsor; 2017.

- L. BHMA A156.25 - American National Standard for Electrified Locking Devices; 2018.
- M. BHMA A156.115 - American National Standard for Hardware Preparation in Steel Doors and Steel Frames; 2016.
- N. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; 2004.
- O. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- P. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2019.
- R. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- S. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2017.
- T. UL (DIR) - Online Certifications Directory; Current Edition.
- U. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.

1.5 SUBMITTALS

- A. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- B. Shop Drawings - Door Hardware Schedule: Submit detailed listing that includes each item of hardware to be installed on each door. Use door numbering scheme as included in Contract Documents.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Provide complete description for each door listed.
- C. Shop Drawings - Electrified Door Hardware: Submit diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:

1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 2. Elevations: Submit front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 3. Diagrams: Submit point-to-point wiring diagram that shows each device in door opening system with related colored wire connections to each device.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- F. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Architect and Contractor.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Hardware to be single sourced from one manufacturer to the greatest extent possible including electrified hardware.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.8 WARRANTY

- A. Warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion.
1. Closers: Five years, minimum.
 2. Exit Devices: Three years, minimum.
 3. Locksets and Cylinders: Three years, minimum.
 4. Other Hardware: Two years, minimum.

PART 2 PRODUCTS

2.1 DESIGN AND PERFORMANCE CRITERIA

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Provide door hardware products that comply with the following requirements:
 - 1. Applicable provisions of federal, state, and local codes.
 - 2. Accessibility: ADA Standards and ICC A117.1.
 - 3. Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 - 4. Hardware on Fire-Rated Doors: Listed and classified by UL (DIR) or testing firm acceptable to authorities having jurisdiction as suitable for application indicated.
 - 5. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.
- D. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
 - 1. Refer to Section 28 1000 for additional access control system requirements.

2.2 HINGES

- A. Manufacturers: Match campus standard. Coordinate with owner.
- B. Hinges: Comply with BHMA A156.1, Grade 1.
 - 1. Provide hinges on every swinging door.
 - 2. Provide power transfer hinges where electrified hardware is mounted in door leaf.
 - 3. Provide following quantity of butt hinges for each door:
 - a. Doors From 60 inches High up to 90 inches High: Three hinges.
 - b. Doors 90 inches High up to 120 inches High: Four hinges.

2.3 FLUSH BOLTS

- A. Manufacturers: Match campus standard. Coordinate with owner.
- B. Flush Bolts: Comply with BHMA A156.16, Grade 1.
 - 1. Flush Bolt Throw: 3/4 inch, minimum.

2.4 EXIT DEVICES

- A. Manufacturers: Match campus standards. Coordinate with owner.

B. Exit Devices: Comply with BHMA A156.3, Grade 1.

1. Lever design to match lockset trim.
2. Provide cylinder with cylinder dogging or locking trim.
3. Provide exit devices properly sized for door width and height.
4. Provide strike as recommended by manufacturer for application indicated.
5. Provide UL (DIR) listed exit device assemblies for fire-rated doors and panic device assemblies for non-fire-rated doors.
6. For electrical options, provide quick connect plug-in pre-wired connectors.

2.5 CYLINDRICAL LOCKS

A. Manufacturers: Match campus standard. Coordinate with owner.

B. Cylindrical Locks (Bored): Comply with BHMA A156.2, Grade 1, 4000 Series.

1. Bored Hole: 2-1/8 inch diameter.
2. Latchbolt Throw: 1/2 inch, minimum.
3. Backset: 2-3/4 inch unless otherwise indicated.
4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.

2.6 MORTISE LOCKS

A. Manufacturers: Match campus standard. Coordinate with owner.

B. Mortise Locks: Comply with BHMA A156.13, Grade 1, Security, 1000 Series.

1. Latchbolt Throw: 3/4 inch, minimum.
2. Deadbolt Throw: 1 inch, minimum.
3. Backset: 2-3/4 inch unless otherwise indicated.
4. Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.
 - a. Finish: To match lock or latch.

2.7 DOOR PULLS AND PUSH PLATES

A. Manufacturers: Match campus standard. Coordinate with owner.

B. Door Pulls and Push Plates: Comply with BHMA A156.6.

1. Pull Type: Straight, unless otherwise indicated.
2. Push Plate Type: Flat, with square corners, unless otherwise indicated.
 - a. Edges: Beveled, unless otherwise indicated.

3. Material: Aluminum, unless otherwise indicated.

2.8 CLOSERS

- A. Manufacturers; Surface Mounted: Match campus standard. Coordinate with owner.
- B. Closers: Comply with BHMA A156.4, Grade 1.
 1. Type: Surface mounted to door.
 2. Provide door closer on each exterior door.
 3. Provide door closer on each fire-rated and smoke-rated door.

2.9 KICK PLATES

- A. Manufacturers: Match campus standard. Coordinate with owner.
- B. Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 1. Size: 8 inch high by 2 inch less door width (LDW) on push side of door.

2.10 WEATHERSTRIPPING AND GASKETING

- A. Manufacturers: Match campus standard. Coordinate with owner.
- B. Weatherstripping and Gasketing: Comply with BHMA A156.22.
 1. Head and Jamb Type: Adjustable.
 2. Door Sweep Type: Encased in retainer.
 3. Material: Aluminum, with brush weatherstripping.

2.11 WIRELESS ACCESS MANAGEMENT SYSTEMS

- A. Manufacturers: Match campus standard. Coordinate with owner.
- B. Wireless Access Management Systems: Comply with guidelines of BHMA A156.25, and including necessary hardware for fully functional system.
 1. Reader Formats: Provide magnetic stripe, proximity, dual validation, or key Fob to activate access system functionality.
 2. Door Locking Hardware: Provide applicable cylindrical locksets, panic hardware, or mortise locksets in compliance with project access control requirements.

2.12 POWER SUPPLY

- A. Manufacturers: Match campus standard. Coordinate with owner.

- B. Power Supply: Hard wired, with multiple zones providing eight (8) breakers for each output panel with individual control switches and LED's; UL (DIR) Class 2 listed.
 - 1. Power: 24 VAC, 10 Amp; with 120 VAC power supply.
 - 2. Operating Temperature: 32 to 110 degrees F.
 - 3. Provide with emergency release terminals that release devices upon activation of fire alarm system.

2.13 FINISHES

- A. Finishes: Provide door hardware of same finish, unless otherwise indicated. Match campus standards.
 - 1. Primary Finish: 625; bright chromium plated over nickel, with brass or bronze base material (former US equivalent US26); BHMA A156.18.
 - 2. Secondary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.
 - a. Use secondary finish in kitchens, bathrooms, and other spaces containing chrome or stainless steel finished appliances, fittings, and equipment; provide primary finish on one side of door and secondary finish on other side if necessary.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B. Verify that electric power is available to power operated devices and of correct characteristics.

3.2 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- C. Use templates provided by hardware item manufacturer.
- D. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
- E. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 01 4000 - Quality Requirements.

3.4 ADJUSTING

- A. Adjust hardware for smooth operation.
- B. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.5 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.

3.6 PROTECTION

- A. Do not permit adjacent work to damage hardware or finish.

END OF SECTION 08 71 00

SECTION 08 80 00 – GLAZING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Insulating glass units.
- B. Glazing compounds and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 08 1113 - Hollow Metal Doors and Frames: Glazed lites in doors.

1.3 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. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2015).
- D. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2015.
- E. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2018c.
- F. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2010.

1.4 SUBMITTALS

- A. Product Data on Insulating Glass Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- B. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- C. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

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

1.6 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.

1.7 WARRANTY

- A. Insulating Glass Units: Provide a five (5) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Float Glass Manufacturers:
 - 1. Guardian Glass, LLC: www.guardianglass.com/#sle.
 - 2. Pilkington North America Inc: www.pilkington.com/na/#sle.
 - 3. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
 - 4. Owner approved substitutions.

2.2 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Fully Tempered Safety Glass: Complies with ANSI Z97.1 or 16 CFR 1201 criteria for safety glazing used in hazardous locations.

2.3 INSULATING GLASS UNITS

- A. Manufacturers:
 - 1. Any of the manufacturers specified for float glass.
- B. Insulating Glass Units: Types as indicated.
 - 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 - 2. 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.
 - 3. Spacer Color: Black.

4. Edge Seal:
 - a. Color: Black.
5. Purge interpane space with dry air, hermetically sealed.

2.4 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.

PART 3 EXECUTION

3.1 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.

3.2 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.

3.3 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. 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.

3.4 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.5 INSTALLATION - DRY GLAZING METHOD (TAPE AND TAPE)

- A. Application - Interior Glazed: Set glazing infills from the interior of the building.
- B. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch above sight line.
- C. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- D. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
- E. Place glazing tape on free perimeter of glazing in same manner described above.
- F. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- G. Carefully trim protruding tape with knife.

3.6 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.

3.7 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste.

- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

3.8 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove non-permanent 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.

END OF SECTION 08 80 00

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Performance criteria for gypsum board assemblies.
- B. Metal stud wall framing.
- C. Cementitious backing board.
- D. Gypsum wallboard.
- E. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Wood blocking product and execution requirements.
- B. Section 09 2216 - Non-Structural Metal Framing.

1.3 REFERENCE STANDARDS

- A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2012.
- B. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2010 (Reaffirmed 2016).
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2019a.
- D. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017.
- E. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.
- F. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2018.
- G. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2018b.
- H. 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. to 0.112 in. in Thickness; 2018.
- I. ASTM C1047 - Standard Specification for Accessories For Gypsum Wallboard and Gypsum

Veneer Base; 2014a.

- J. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.
- K. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2016.
- L. GA-216 - Application and Finishing of Gypsum Panel Products; 2016.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate special details associated with fireproofing.
- 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.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing gypsum board installation and finishing, with minimum 5 years of experience.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.
- B. Fire Rated Assemblies: Provide completed assemblies with the following characteristics:
 - 1. Fire Rated Partitions: See plans.

2.2 METAL FRAMING MATERIALS

- A. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich: www.clarkdietrich.com/#sle.
 - 2. Jaimes Industries: www.jaimesind.com/#sle.
 - 3. Steel Construction Systems: www.steelconsystems.com/#sle.
- B. Non-structural Steel Framing for Application of Gypsum Board: As specified in Section 09 2216.
- C. Non-structural 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.
- D. 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.
- E. Deflection and Firestop Track: Intumescent strip factory-applied to track flanges expands when exposed to heat or flames to provide a perimeter joint seal.

2.3 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 3. National Gypsum Company: www.nationalgypsum.com/#sle.
 4. USG Corporation: www.usg.com/#sle.
- B. 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. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 - a. Mold resistant board is required at all locations.
 3. 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.
 4. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
- C. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
1. Application: Vertical surfaces behind thinset tile, except in wet areas.
 2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
 3. Regular Board Thickness: 5/8 inch.
 4. Edges: Tapered.

2.4 GYPSUM WALLBOARD ACCESSORIES

- A. Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.
- B. Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.
 - 1. Fiberglass Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
 - 2. Joint Compound: Drying type, vinyl-based, ready-mixed.
 - 3. Joint Compound: Setting type, field-mixed.
- C. High Build Drywall Surfer: Vinyl acrylic latex-based coating for spray application, designed to take the place of skim coating and separate paint primer in achieving Level 5 finish.
- D. 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

3.1 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.2 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.
- B. Studs: Space studs at 16 inches on center.
 - 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.
- C. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- D. Blocking: Install wood blocking for support of:
 - 1. Framed openings.
 - 2. Wall mounted cabinets.
 - 3. Plumbing fixtures.
 - 4. Toilet partitions.
 - 5. Toilet accessories.

3.3 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. Fire-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- D. Cementitious Backing Board: Install over steel framing members where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.4 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.

3.5 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, embed with drying type joint compound and finish with drying type joint compound.
- B. 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 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 4. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
- D. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.6 TOLERANCES

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION 09 21 16

SECTION 09 30 00 – TILING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Ceramic trim.
- D. Non-ceramic trim.

1.2 RELATED REQUIREMENTS

- A. Section 07 9200 - Joint Sealants: Sealing joints between tile work and adjacent construction and fixtures.
- B. Section 09 2116 - Gypsum Board Assemblies: Tile backer board.

1.3 REFERENCE STANDARDS

- A. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2014.
- 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; 1999 (Reaffirmed 2010).
- 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 2010).
- 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; 1999 (Reaffirmed 2010).
- J. ANSI A108.12 - American National Standard for Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Latex-Portland Cement Mortar; 1999 (Reaffirmed 2010).
- K. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2005 (Reaffirmed 2010).
- L. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2017.
- M. ANSI A118.1 - American National Standard Specifications for Dry-Set Cement Mortar; 2012 (Revised).
- 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 A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile; 2008 (Reaffirmed 2013).
- U. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2012.
- V. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2017.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- B. Provide manufacturer's standard warranty.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Installer's Qualification Statement:
 - 1. Submit documentation of National Tile Contractors Association (NTCA) or Tile Contractors' Association of America (TCAA) accreditation.
- 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. Extra Tile: 10 square feet (1 square meters) of each size, color, and surface finish combination.

1.6 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:
 - 1. Company specializing in performing tile installation, with minimum of five years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.8 FIELD CONDITIONS

- A. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F prior to installation and during installation and curing of setting materials.

PART 2 PRODUCTS

2.1 TILE

- A. Manufacturers: Match campus standard, including floor and wall tile size and color. Coordinate with owner.

1. American Olean Corporation: www.americanolean.com/#sle. BASIS OF DESIGN.

B. Wall Tile: Coordinate with owner.

1. Type: Ceramic tile
2. Series: Bricktown
3. Color/Pattern: Cashmere Court BT-10
4. Size: 4 in x 8 in
5. Grout Color: Match campus standard
6. Pattern: Running Bond
7. Trim: Stainless Emac trimpiece at outside corners.

C. Porcelain Floor Tile: Coordinate with owner.

1. Series: Relevance
2. Color/Pattern: Charcoal unpolished RL-04
3. Size: 24 in x 24 in
4. Grout Color: Laticrete-coordinate with owner.
5. Pattern: Standard

2.2 TRIM AND ACCESSORIES

A. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive. Match campus standard.

1. Applications:
 - a. Open edges of wall tile.
 - b. Wall corners, outside and inside.
 - c. Thresholds at door openings.
 - d. Expansion and control joints, floor and wall.

2.3 SETTING MATERIALS

- A. Latex-Portland Cement Mortar Bond Coat (thin set): ANSI A118.4.
- B. Medium Bed Latex-Portland Cement Mortar : Comply with requirements in ANSI A118.4.
- C. Organic Adhesive: ANSI A136.1, thinset mastic type.
- D. Water -Cleanable, Tile-Setting Epoxy: ANSI A118.3.
- E. Dry-Set Portland Cement Mortar Bond Coat (thin set): ANSI A118.1.

2.4 GROUTS

- A. Polymer Modified Tile-Grout: ANSI A118.7
- B. Sand-Portland Cement Grout: ANSI A118.10 composed of white or gray cement and white or

colored aggregate as required to produce color indicated.

- C. Standard Cement Grout: ANSI A118.6.
- D. Water cleanable Epoxy Grout: ANSI A118.3 chemical resistant and water-cleanable epoxy grout.

2.5 MAINTENANCE MATERIALS

- A. Tile Sealant: Gunnable, silicone, siliconized acrylic, or urethane sealant; moisture and mildew resistant type.
 - 1. Applications: Between tile and plumbing fixtures.
- B. Grout Sealer: Liquid-applied, moisture and stain protection for existing or new Portland cement grout.
 - 1. Composition: Water-based colorless silicone.
- C. Tile Sealer: Stain protection.

2.6 ACCESSORY MATERIALS

- A. Concrete Floor Slab Crack Isolation Membrane: Material complying with ANSI A118.12; not intended as waterproofing.
 - 1. Crack Resistance: No failure at 1/8 inch gap, minimum.
- B. Waterproofing Membrane at Floors: Specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.

PART 3 EXECUTION

3.1 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.

3.2 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. Provide floor leveling compound (Ardex) if required.

3.3 INSTALLATION - GENERAL

- A. Install tile and thresholds and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.19 , manufacturer's instructions, and TCNA (HB) recommendations.
- B. Floor pattern to match existing. 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.

3.4 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.

3.5 INSTALLATION - WALL TILE

- A. Over cementitious backer units on studs, install in accordance with TCNA (HB) Method W244, using membrane at toilet rooms.

3.6 CLEANING

- A. Clean tile and grout surfaces until no haze is visible on tile surfaces.

3.7 PROTECTION

- A. Do not permit traffic over finished floor surface for 4 days after installation. Protect during remainder of construction. Repair or replace any tiles that are damaged.

END OF SECTION 09 30 00

SECTION 09 51 00 - ACOUSTICAL CEILINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units. Ceiling tile panels.
- C. Clean Room Acoustical Tile Ceilings.

1.2 RELATED REQUIREMENTS

- A. Section 21 1300 - Fire-Suppression Sprinkler Systems: Sprinkler heads in ceiling system.
- B. Section 23 3713 - Air Outlets and Inlets: Air diffusion devices in ceiling.
- C. Section 26 5119 - LED interior Lighting.
- D. Section 28 3111 - Digital Addressable Fire Alarm System.

1.3 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- C. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2017.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate grid layout and related dimensioning and mechanical and electrical items installed in the ceiling.

- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Acoustical Units: Quantity equal to 5 percent of total installed.

1.6 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.

1.7 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc; See room finish schedule for types: www.armstrongceilings.com/#sle.
 - 2. USG: www.usg.com.

2.2 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.

2.3 ACOUSTICAL PANELS

- 1. Size: 24 x 48 inches.
- 2. Suspension System: Exposed grid.

2.4 CLEAN ROOM ACOUSTICAL TILES

- 1. Basis of Design: Subject to compliance with project requirements, the design is based on the following: USG Interiors, LLC, "Clean Room".
- 2. Classification: Provide ceiling panels complying with ASTM E 1264 for type, form and pattern as follows:

- a. Type: X, mineral base with membrane faced overlay
 - b. Form: Not Applicable
 - c. Pattern: smooth and embossed.
- 3. Color: Manufacturers standard Flat White 050.
 - 4. LR: Not less than 0.79.
 - 5. NRC: Not less than 0.55.
 - 6. CAC: Not less than 35.
 - 7. Edge/Joint Detail: SQ Square.
 - 8. Suspension Grid/Width: 15/16 inch.
 - 9. Panel Thickness: 5/8 inch.
 - 10. Modular Size: 2 4 by 48 inches, As indicated on Drawings.
 - 11. Recycled Content: Up to 55%.
 - 12. High Recycled Content: Classified as containing greater than 50% total recycled content. Total recycled content is based on product composition of post-consumer and pre-consumer post-industrial recycled content per FTC guidelines.
 - 13. VOC Emissions: Third party (GREENGUARD Gold) certified for low-emitting performance, meets California Department of Department of Public Health's (CDPH) Standard Method v1.1-2010 (CA Section 01350). 'Certificates of Compliance' for Low VOC Emissions are available on usg.com and at productguide.ulenvironment.com.
 - 14. Panel Features: Firecode®, fire rated and designed to meet life safety codes.
 - 15. ClimaPlus™ 30 year limited system warranty. Contains a broad spectrum antimicrobial additive on the face and back of the panel that provides resistance against the growth of mold and mildew. Includes sag resistance performance.

2.5 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 1. Materials:
 - a. Aluminum Grid: Aluminum sheet, ASTM B209 (ASTM B209M).

2.6 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12-gage 0.08-inch galvanized steel wire.
- C. Hold-Down Clips: Manufacturer's standard clips to suit application.
- D. Perimeter Moldings: Same metal and finish as grid.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.3 INSTALLATION - SUSPENSION SYSTEM

- A. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- C. Locate system on room axis according to reflected plan.
- D. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
- E. Use longest practical lengths.
- F. Suspension System, Non-Seismic: 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. Minimum spacing between hangers to be equal to or less than 4'-0" o.c.
- 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 (152 mm) of each corner, or support components independently.
- J. Do not eccentrically load system or induce rotation of runners.

3.4 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Provide hold-down clips in entry vestibules and where called for in construction documents.

- C. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- D. Fit border trim neatly against abutting surfaces.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.
- G. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.

3.5 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION 09 51 00

SECTION 09 65 00 - RESILIENT FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Resilient tile flooring.
- B. Resilient base.
- C. Installation accessories.

1.2 REFERENCE STANDARDS

- A. ASTM F1861 - Standard Specification for Resilient Wall Base; 2016.

1.3 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in installing specified flooring with minimum three years documented experience.

1.5 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.

1.6 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

2.1 TILE FLOORING

- A. Vinyl Composition Tile: Homogeneous, with color extending throughout thickness.
 - 1. Minimum Requirements: Comply with ASTM F1066, of Class corresponding to type specified.
 - 2. Size: 12 by 12 inch.
 - 3. Thickness: 0.125 inch.
 - 4. Pattern: Solid color.
 - 5. Manufacturers – basis of design:
 - a. Armstrong World Industries, Inc: www.armstrong.com.
 - b. Premium Excellon.
 - 6. Color and pattern to be selected by Senior Mechanical Facility Engineer.

2.2 RESILIENT BASE

- A. Resilient Base: ASTM F1861, Type TS rubber, vulcanized thermoset; top set Style B, Cove.
 - 1. Manufacturers:
 - a. Roppe Corp: www.roppe.com/#sle.
 - b. Substitutions as approved by owner.
 - 2. Height: 4 inch.
 - 3. Thickness: 0.125 inch.
 - 4. Finish: Satin.
 - 5. Length: Roll.
 - 6. Color: To be selected by Owner from manufacturer's full range.
 - 7. Accessories: Premolded external corners and internal corners.

2.3 ACCESSORIES

- A. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
- B. Moldings, Transition and Edge Strips: Same material as flooring.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.

3.2 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.

3.3 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of conditions.
- B. Install in accordance with manufacturer's written instructions and manufacturers suggested maximum length to minimize joints.
- C. Spread only enough adhesive to permit installation of materials before initial set.
- D. Fit joints tightly.
- E. Set flooring in place, press with heavy roller to attain full adhesion.
- F. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
- G. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
- H. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.

3.4 TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer's instructions say otherwise.

3.5 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches (45 mm) between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.6 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

END OF SECTION 09 65 00

SECTION 09 67 00 - RESINOUS FLOORING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Resinous Floor Systems:

1.2 RELATED SECTIONS

- A. Section 03300 - Cast-In-Place Concrete.

1.3 REFERENCES

- A. ASTM International (ASTM):

1. ASTM C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
2. ASTM C 128 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
3. ASTM C 307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
4. ASTM C 348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
5. ASTM C 413 - Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
6. ASTM C 579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
7. ASTM D 257 - Standard Test Methods for DC Resistance or Conductance of Insulating Materials.
8. ASTM D 1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
9. ASTM D 1475 - Standard Test Method For Density of Liquid Coatings, Inks, and Related Products.
10. ASTM D 2047 - Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
11. ASTM D 2134 - Standard Test Method for Determining the Hardness of Organic Coatings with a Sward-Type Hardness Rocker.
12. ASTM D 2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
13. ASTM D 2369 - Standard Test Method for Volatile Content of Coatings.
14. ASTM D 2370 - Standard Test Method for Tensile Properties of Organic Coatings.
15. ASTM D 2393 - Test Method for Viscosity of Epoxy Resins and Related Components.
16. ASTM D 2697 - Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings.
17. ASTM D 3278 - Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus.
18. ASTM D 3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.

19. ASTM D 4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
20. ASTM D 4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
21. ASTM D 7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
22. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate. of Concrete Subfloor Using Anhydrous Calcium Chloride.
23. ASTM F 2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.4 SUBMITTALS

A. Product Data:

1. Manufacturer's data sheets on each product to be used, including properties, VOC content, wet static coefficient of friction, compressive strength, tensile strength, elongation and similar properties.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Typical installation methods.

B. Verification Samples: Two representative units of each system, including color and texture.

C. Shop Drawings: Include details of materials, construction and finish. Include relationship with adjacent construction.

D. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

E. Manufacturer's Project References: Submit manufacturer's list of successfully completed resinous flooring system projects, including project name and location, name of architect, and type and quantity of flooring systems furnished.

F. Applicator's Project References: Submit applicator's list of successfully completed resinous flooring system projects, including project name and location, name of architect, and type and quantity of flooring systems applied.

G. Care and Maintenance Instructions: Submit manufacturer's care and maintenance instructions, including cleaning instructions.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum five years documented experience.

B. Applicator's Qualifications:

1. Applicator regularly engaged, for a minimum of 5 years, in application of resinous flooring systems of similar type to that specified.

2. Employ persons trained for application of resinous flooring systems.
- C. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.
- D. Mock-Up: Construct a mock-up with actual materials in sufficient time for Owner's review and to not delay construction progress. Locate mock-up as acceptable to Owner and provide temporary foundations and support.
 1. Intent of mock-up is to demonstrate quality of workmanship and visual appearance.
 2. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
 3. Retain mock-up during construction as a standard for comparison with completed work.
 4. Do not alter or remove mock-up until work is completed or removal is authorized.

1.6 PRE-INSTALLATION CONFERENCE

- A. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Owner, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, and batch number.
- B. Storage and Handling Requirements:
 1. Store and handle materials in accordance with manufacturer's instructions.
 2. Keep materials in manufacturer's original, unopened containers and packaging until application.
 3. Store materials in clean, dry area indoors between 65 and 80 degrees F.
 4. Store materials out of direct sunlight.
 5. Keep materials from freezing.
 6. Protect materials during storage, handling, and application to prevent contamination or damage.

1.8 PROJECT CONDITIONS

- A. Apply flooring system under the following ambient conditions:
 1. Ambient and Concrete Floor Temperatures: Between 40 and 85 degrees F.
 2. Material Temperature: Between 50 and 80 degrees F.
 3. Relative Humidity: Maximum 80 percent.
 4. Dew Point: Floor temperature more than 5 degrees over dew point.
- B. Do not apply flooring system under ambient conditions outside manufacturer's limits.

1.9 WARRANTY

- A. Submit manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Tennant Coatings Inc., which is located at: 701 N. Lilac Dr.; Minneapolis, MN 55440
- B. Substitutions as approved by Owner

2.2 TENNANT ECO-CRETE MF/ESD

- A. Customized Systems, Tennant Eco-Crete MF:

- 1. Primer: Eco-Crete TC.
- 2. Mortar: Eco-Crete MF.
- 3. Intermediate Coat: Eco-MPE.
- 4. Top Coat: Eco-SDS.

2.3 PRODUCT PROPERTIES

- A. Eco-Crete MF: A three-part, cementitious-polyurethane slurry system, for resurfacing lightly eroded interior concrete floors in areas that require thermal shock resistance, this system provides a smooth finish. Typically installed at 1/8 inch.

- 1. Compressive Strength, ASTM C579: 7,200 psi.
- 2. Tensile Strength. ASTM C307: 1,050 psi.
- 3. Flexural Strength, ASTM C580: 2,700 psi.
- 4. Bond Strength, ASTM D4541: 100 Percent Concrete Failure.
- 5. Impact Strength, ASTM D4226: Greater than 160 in/lb.
- 6. Volatile Organic Compound, VOC, ASTM D3960, Mixed A+B+C: 0.04 lb./gal.
- 7. Resistance to Fungi Growth, ASTM G21: Passes, Rating 1.
- 8. Flammability, ASTM D635: Self-extinguishing.

- B. Eco-MPE: A neutral, two-component, high solids epoxy.

- 1. Percent Solids, by weight (by volume), ASTM D1475, A + B: 95.45 (94.56).
- 2. Volatile Organic Compound-VOC, ASTM D3960, Mixed A + B: 0.41 lb./gal.
- 3. Abrasion Resistance, mg loss, Taber Abraser, C-17 Taber Abrasion Wheel, 1,000 gram load, 1,000 revolutions, ASTM D4060: 83.1.
- 4. Coefficient of Friction-COF, James Friction Tester, ASTM D2047: 0.59-0.62.
- 5. Adhesion to Concrete, ASTM D5441: 732 psi concrete failed.
- 6. Adhesion to Concrete, ASTM D7234: 450 psi concrete failed.
- 7. Compressive Strength, ASTM D695: 13,500 psi.
- 8. Tensile Strength, ASTM D2370: 8,000 psi.

9. Percent Elongation, ASTM D2370: 5.
 10. Shore D Hardness, ASTM D2240: 80-85 at 0 sec, 75-80 at 15 sec.
- C. Eco-SDS-Satin: Is a high solids and light stable urethane which has a satin appearance for long lasting durability. Applied over Eco-MPE primer or may be used to recoat an existing epoxy or urethane floor coating.
1. Surface Resistance, Point to Point / Point to Ground, ESD Assoc. ANSI/ESD 7.12005, 1x10⁵ ohms to less than 1x10⁹.
 2. Resistance to Ground in Combination with a Person, ANSI/ESD STM 97.1 (ANSI/ESD S20.20-Mthod 1), less than 3.5x10⁷ ohms (ESD shoes or heel straps).
 3. Body Voltage Generation, ANSI/ESD STM 97.2 (ASNI/ESD S20.20-Method 2), 12 volts with ESD shoes, 32 volts with heel straps.
 4. Body Voltage Decay (with ESD shoes of heel straps), AATCC 134-1979 (modified), 1,000 volts to less than 10 volts in less than 1.0 second.
 5. Volatile Organic Compound-VOC, ASTM D3960, 0.11 lb./g.
 6. Abrasion Resistance, Taber Abraser, CS-17 Taber Abrasion Wheel, 1,000 gram load, 1,000 revolutions, ASTM D4060, 38.
 7. Adhesion to Concrete, ASTM D4454, 450 psi.
 8. Adhesion to Concrete, ASTM D7234, 732 psi.
 9. Coefficient of Friction, James Friction Tester, ASTM D2047, 0.50.
 10. Wet Static Coefficient of Friction-BOT 3000, ANSI/NSFI V101.1, 0.95.
 11. Compressive Strength (epoxy), ASTM D695, 13,500 psi.
 12. Flammability/Rate of Burn (topcoat resin), ASTM D635, 50 mm/min.
 13. Tensile Strength, ASTM D2370, 6,250 psi.
 14. Percent Elongation, ASTM D2370, 6.
 15. Resistance to Yellowing, AS measured using ASTM D2244 after 1000 consecutive hours UV exposure in QUV, ASTM G154, less than 10 increase to yellow units (CIE Lab Delta b).
 16. Konig Hardness (3mil/0.08 mm film) (topcoat resin), ASTM D4366, 171.3.
 17. Shore D Hardness (epoxy), ASTM D2240, 80-85 at 0 Sec, 75-80 at 15 sec Water Absorption (24-hour immersion), ASTM D570, 0.2 percent weight increase.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine concrete surfaces to receive flooring system. Verify concrete is structurally sound.
- B. Moisture Testing of Concrete: Perform at least one of the following two tests to determine moisture in concrete. Type of test and frequency as recommended by manufacturer and installer.
 1. Calcium Chloride Test:
 - a. Measure moisture vapor emission rate of concrete in accordance with ASTM F 1869.
 - b. Application of flooring system shall start only if test results are below 3 pounds per 1,000 sq.ft over a 24-hour period.
 - c. If test results are above limits, notify Architect and flooring manufacturer in writing.

2. In-Site Probe Test:

- a. Measure relative humidity in concrete in accordance with ASTM F 2170.
 - b. Application of flooring system shall start only if test results are below 75 percent relative concrete humidity.
 - c. If test results are above limits, notify Architect and flooring manufacturer in writing.
- C. Do not begin preparation or installation until satisfactory moisture test results are achieved. Provide flooring manufacturer's recommended moisture vapor control coating if required.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Protection of In-Place Conditions: Protect adjacent surfaces and adjoining walls from contact with flooring system materials.
- C. Surface Preparation:
1. Prepare concrete surface in accordance with manufacturer's instructions.
 2. Remove dirt, dust, debris, oil, grease, curing agents, bond breakers, paint, coatings, sealers, silicones, and other surface contaminants which could adversely affect application of flooring system.
 3. Steel shot blast concrete to a minimum surface profile of ICRI 310.2R, CSP 5.
 4. Key-cut termination points with 1/4-inch by 1/4-inch cut.
 5. Patch depressions, divots, and cracks in concrete in accordance with manufacturer's instructions.
 6. Mechanically remove loose, delaminated, and damaged concrete and repair in accordance with manufacturer's instructions.
 7. Joints: Fill joints in accordance with manufacturer's instructions.

3.3 INSTALLATION

- A. Install flooring system in accordance with manufacturer's instructions and approved submittals at locations indicated on the Drawings.
- B. Ensure concrete is dry, clean, and prepared in accordance with manufacturer's instructions.
- C. Allow concrete to cure a minimum of 7 days before applying flooring system at new floor slabs – refer to structure drawings for locations.
- D. Mixing:
1. Mix material components together in accordance with manufacturer's instructions.
 2. Mix only enough material that can be applied within working time.
 3. Add and mix colorants with materials in accordance with manufacturer's instructions to achieve uniform color.
- E. Apply flooring system materials to obtain consistent mil thickness and smooth, uniform appearance and texture.

- F. Overlay: Apply overlay in accordance with manufacturer's instructions. Apply overlay to prepared concrete surface.
- G. Traction Aggregate: Broadcast traction aggregate in accordance with manufacturer's instructions. Broadcast traction aggregate into wet overlay.
- H. Cove:
 - 1. Apply cove primer and cove in accordance with manufacturer's instructions at locations indicated on the Drawings.
 - 2. Apply cove to height and shape as indicated on the Drawings. (Minimum 4" High)
 - 3. Apply cove to create seamless, smooth transition between flooring and walls.
- I. Seal Coat:
 - 1. Apply seal coat in accordance with manufacturer's instructions.
 - 2. Apply seal coat over traction aggregate.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Coordinate field inspection in with Owner's rep.
- B. Manufacturer's Services: Coordinate manufacturer's services in with Owner's rep.

3.5 CLEANING AND PROTECTION

- A. Allow flooring system to dry in with manufacturer's instructions before opening to traffic.
- B. Allow flooring system to dry a minimum of 1 week before cleaning by mechanical means.
- C. Protect completed flooring system from damage during construction.

END OF SECTION 09 67 00

SECTION 09 68 13 - TILE CARPETING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.2 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- B. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
- C. Shop Drawings: Indicate layout of joints.
- D. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- E. Manufacturer's Qualification Statement.
- F. Manufacturers standard warranty.
- G. Installer's Qualification Statement.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum three years documented experience.

1.4 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Tile Carpeting:
 - 1. Interface, Inc: www.interfaceinc.com.
 - 2. Milliken & Company: www.milliken.com.
 - 3. Or approved equal.

2.2 ACCESSORIES

- A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
- B. Edge Strips: Embossed aluminum, color as selected by Architect.
- C. Carpet Tile Adhesive: Recommended by carpet tile manufacturer; releasable type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.

3.2 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.

3.3 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor 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. Fully adhere carpet tile to substrate.
- G. Trim carpet tile neatly at walls and around interruptions.
- H. Complete installation of edge strips, concealing exposed edges.

3.4 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 09 68 13

SECTION 09 91 23 - INTERIOR PAINTING

PART 1 GENERAL

1.1 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.
- 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. Floors, unless specifically indicated.
 - 6. Glass.
 - 7. Concealed pipes, ducts, and conduits.

1.2 REFERENCE STANDARDS

- A. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual; Current Edition.
- B. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- C. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.3 SUBMITTALS

- A. 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. Manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

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

- B. Applicator Qualifications: Company specializing in performing the type of work specified approved by manufacturer.

1.5 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.

1.6 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

2.1 MANUFACTURERS

- A. Provide paints and finishes used in any individual system from the same manufacturer; no exceptions.
- B. Paints:
 - 1. Behr Process Corporation: www.behr.com/#sle.
 - 2. PPG Paints: www.ppgpaints.com/#sle.
 - 3. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 4. Glidden Professional, a product of PPG Architectural Coatings: www.gliddenprofessional.com.
 - 5. Benjamin Moore & Co: www.benjaminmoore.com.
- C. Substitutions as approved by owner.

2.2 PAINTS AND FINISHES - GENERAL

- A. Paints and Finishes: Ready mixed, unless intended to be a field-catalyzed paint.
 - 1. 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.
2. Supply each paint material in quantity required to complete entire project's work from a single production run.
 3. Do not reduce, thin, or dilute paint or finishes or add materials unless such procedure is specifically described in manufacturer's product instructions.

2.3 PAINT SYSTEMS - INTERIOR

- A. Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete masonry units, and shop primed steel.
 1. Two top coats and one coat primer.

2.4 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

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
- B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially 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. Gypsum Wallboard: 12 percent.
 2. Masonry, Concrete, and Concrete Masonry Units: 12 percent.

3.2 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, door 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. Masonry:
- F. Gypsum Board: Fill minor defects with filler compound. Spot prime defects after repair.
- 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 methods recommended in writing by paint manufacturer and blast cleaning according to SSPC-SP 6 "Commercial Blast Cleaning". Protect from corrosion until coated.

3.3 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. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.4 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.5 PROTECTION

- A. Protect finishes until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 09 91 23

SECTION 09 96 00 - HIGH-PERFORMANCE COATINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. High performance coatings.
- B. Surface preparation.

1.2 REFERENCE STANDARDS

- A. MPI (APL) - Master Painters Institute Approved Products List; Master Painters and Decorators Association Current Edition.
- B. MPI (APSM) - Master Painters Institute Architectural Painting Specification Manual Current Edition.

1.3 SUBMITTALS

- A. 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.
- B. Manufacturer's Certificate: Certify that high-performance coatings comply with VOC limits specified.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

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

1.5 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 (7 degrees C) and a maximum of 90 degrees F (32 degrees C), in ventilated area, and as required by manufacturer's instructions.

1.6 FIELD CONDITIONS

- A. Do not install materials when temperature is below 55 degrees F (13 degrees C) or above 90 degrees F (32 degrees C).
- B. Maintain this temperature range, 24 hours before, during, and 72 hours after installation of coating.
- C. Provide lighting level of 80 ft candles (860 lx) measured mid-height at substrate surface.
- D. Restrict traffic from area where coating is being applied or is curing.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Only materials (primers, coatings, etc.) listed in the latest edition of the MPI Approved Product List (APL) are acceptable for use on this project.
- B. Provide high performance coating products from the same manufacturer to the greatest extent possible.
- C. High-Performance Coatings:

2.2 HIGH-PERFORMANCE COATINGS

- A. Provide coating systems that meet the following minimum performance criteria, unless more stringent criteria are specified:

2.3 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 Room 317 - Iso Clean Room:
 - 1. Number of coats: Two.
 - 2. Top Coat(s): Polyamide Epoxy; MPI #77, #177.
 - a. Sheen: Gloss.
 - b. Products:
 - 1) PPG Paints; Aquapon High Build Polyamide Epoxy, 97-1212 Series, Semi-Gloss: www.ppgpaints.com/#sle.
 - 2) Sherwin-Williams; Macropoxy 646-100 Epoxy, B58-600 Series: www.protective.sherwin-williams.com/#sle.
 - 3) Sherwin-Williams; Tile Clad HS: www.protective.sherwin-williams.com/#sle. (MPI #77)
 - 4) Tnemec Company, Inc; Series 287 Enviro-Pox: www.tnemec.com/#sle.
- C. Shellac: Pure, white type.

2.4 PRIMERS

- A. Primers: Provide the following unless other primer is required or recommended by coating manufacturer.

1. Primer Sealer, Latex, Interior; MPI #50.

2.5 ACCESSORY MATERIALS

- A. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of coated surfaces.

PART 3 EXECUTION

3.1 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.

3.2 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. Protect adjacent surfaces and materials not receiving coating from spatter and overspray; mask if necessary to provide adequate protection. Repair damage.

3.3 PRIMING

- A. Apply primer to all surfaces, unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.

3.4 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.

3.5 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.

END OF SECTION 09 96 00

SECTION 10 14 00 – SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Room and door signs.

1.2 RELATED REQUIREMENTS

- A. Section 26 5213 – Emergency and Exit Lighting.

1.3 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.

1.4 SUBMITTALS

- A. 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.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Package signs as required to prevent damage before installation.
- B. Package room and door signs in sequential order of installation, labeled by floor or building.
- C. Store tape adhesive ambient room temperature.

1.7 FIELD CONDITIONS

- A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

- B. Maintain temperature during and after installation of signs.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Flat Signs: Match Campus Standards. Coordinate with owner.

2.2 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 at 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.

2.3 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: Match campus standard. Coordinate with owner.

2.4 TACTILE SIGNAGE MEDIA

- A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:

1. Total Thickness: 1/16 inch.

2.5 ACCESSORIES

- A. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrate surfaces are ready to receive work. Painted wall surfaces must be fully completed, with all coats, prior to installation.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Install at mounting heights indicated in the drawings and/or specified height where required by either the building code or AHJ ordinances. If any discrepancy exists, review with the local code official.
- B. Install neatly, with horizontal edges level.
- C. Protect from damage until Substantial Completion; repair or replace damaged items.

END OF SECTION 10 14 00

SECTION 10 21 13.13 - METAL TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal toilet compartments.
- B. Urinal screens.

1.2 RELATED REQUIREMENTS

- A. Section 05 5000 - Metal Fabrications: Concealed steel support members.
- B. Section 06 1000 - Rough Carpentry: Blocking and supports.
- C. Section 10 2800 - Toilet, Bath, and Laundry Accessories.

1.3 REFERENCE STANDARDS

- A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with placement of support framing and anchors in walls and ceilings.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate partition plan, elevation views, dimensions, details of wall, floor, and ceiling supports, door swings including minimum ADA clearances.
- B. Product Data: Provide data on panel construction, hardware, and accessories.
- C. Manufacturer's Installation Instructions: Indicate special procedures.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Toilet Compartments:
 - 1. All American Metal Corp - AAMCO: www.allamericanmetal.com/#sle.

2. General Partitions Mfg. Corp: www.generalpartitions.com/#sle.
3. Global Steel Products Corp: www.globalpartitions.com/#sle.
4. Metpar Corp: www.metpar.com/#sle.
5. Substitutions as approved by owner.

2.2 MATERIALS

- A. Stainless Steel Sheet: ASTM A666, Type 304.

2.3 COMPONENTS

- A. Toilet Compartments: Stainless steel, ceiling-hung.
- B. Doors, Panels, and Pilasters: Sheet steel faces, pressure bonded to sound deadening core, formed and closed edges; corners made with corner clips or mitered, welded, and ground smooth.
1. Panel Faces: 20 gage, 0.0359 inch.
 2. Door Faces: 22 gage, 0.0299 inch.
 3. Pilaster Faces: 20 gage, 0.0359 inch.
 4. Reinforcement: 12 gage, 0.1046 inch.
 5. Internal Reinforcement: Provide in areas of attached hardware and fittings. Mark locations of reinforcement for partition mounted washroom accessories.
- C. Door and Panel Dimensions:
1. Thickness: 1 inch.
 2. Door Width: 24 inch.
 3. Door Width for Handicapped Use: 36 inch, out-swinging.
 4. Height: 58 inch.
- D. Pilasters: 1-1/4 inch thick, of sizes required to suit compartment width and spacing.
- E. Urinal Screens: Wall mounted with two panel brackets.

2.4 ACCESSORIES

- A. Brackets: Polished chrome-plated non-ferrous cast metal.
- B. Hardware: Polished chrome plated non-ferrous cast metal:
1. Pivot hinges, gravity type, adjustable for door close positioning; two per door.
 2. Thumb turn or sliding door latch with exterior emergency access feature.
 3. Door strike and keeper with rubber bumper; mounted on pilaster in alignment with door latch.
 4. Coat hook with rubber bumper; one per compartment, mounted on door.
 5. Provide door pull for outswinging doors.

2.5 FINISHING

- A. Stainless Steel Compartments: No. 4 finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.2 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's instructions.
- B. Maintain 3/8 to 1/2 inch space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using anchor devices.
- D. Attach panels and pilasters to brackets. Locate head rail joints at pilaster center lines.

3.3 TOLERANCES

- A. Maximum Variation From True Position: 1/4 inch.

3.4 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust hinges to position doors in partial opening position when unlatched. Return out swinging doors to closed position.
- C. Adjust adjacent components for consistency of line or plane.
- D. Clean and protect partitions.

END OF SECTION 10 21 13.13

SECTION 10 22 13 - WIRE MESH PARTITIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wire mesh systems for walls.

1.2 SUBMITTALS

- A. Shop Drawings: Indicate plan and vertical dimensions, elevations, component details; head, jamb, and sill details; location of hardware. Provide component details, anchorage, and type and location of fasteners.
- B. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Wire Mesh Partitions:
 - 1. Acorn Wire and Iron Works, Inc: www.acornwire.com/#sle.
 - 2. The G-S Company; Sure Guard Standard Duty: www.g-sco.com/#sle.
 - 3. Substitutions as approved by Owner.

2.2 WIRE MESH PARTITIONS

- A. Wire Mesh Partitions: Factory-fabricated modular assemblies of panels, doors, anchors, hardware, and accessories as required to provide a complete system.

2.3 COMPONENTS

- A. Woven Wire Mesh: Standard duty.
 - 1. Material: ASTM A510/A510M uncoated crimped steel wire.
 - 2. Wire Size: 10 gage, 0.135 inch.
 - 3. Mesh Opening Size: 1-1/2 inch diamond shape.

- B. Doors: Same material as partitions, fully framed; manufacturer's standard construction and hardware for sliding operation.

- 1. Locking: Integrated padlock hasps for padlocks provided by Owner.

2.4 FASTENERS

- A. Bolts, Nuts and Washers: Hot dip galvanized.
- B. Anchorage Devices: Provide power driven, powder actuated, and drilled expansion bolts.

2.5 ACCESSORIES

- A. Bracing: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.
- B. Plates, Gussets, Clips: Formed sheet steel, thickness determined for conditions encountered, manufacturer's standard shapes, same finish as framing members.
- C. Post Caps: Manufacturer's standard.
- D. Floor Base: Manufacturer's standard.

2.6 FABRICATION

- A. Fit and assemble in largest practical sections for delivery to site, ready for installation.
- B. Make exposed joints flush or tight.

2.7 FINISHES

- A. Painted Finish: Manufacturer's standard powder coat finish.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean substrate surfaces.

3.3 INSTALLATION

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

3.4 TOLERANCES

- A. Maximum Variation From Plumb or Level: 1/4 inch.

3.5 ADJUSTING

- A. Adjust doors to achieve free movement.

3.6 CLEANING

- A. Remove temporary protection to prefinished surfaces.
- B. Protect until substantial completion.

END OF SECTION 10 22 13

SECTION 10 28 00 - TOILET ROOM ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Commercial toilet accessories.
- B. Utility room accessories.

1.2 RELATED REQUIREMENTS

- A. Section 10 21 13.13 - Metal Toilet Compartments.

1.3 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2015.
- C. ASTM C1036 - Standard Specification for Flat Glass; 2016.
- D. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.

1.4 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.

1.5 SUBMITTALS

- A. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
- B. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Commercial Toilet and Bath Accessories: Basis of design -Bobrick Washroom Equipment
 - 1. Substitutions as approved by owner.
- B. Provide products of each category type by single manufacturer. Refer to toilet accessory schedule on the drawings.

2.2 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.
- B. Stainless Steel Sheet: ASTM A666, Type 304.
- C. Mirror Glass: Tempered safety glass, ASTM C1048; and ASTM C1036 Type I, Class 1, Quality Q2, with silvering as required.
- D. Fasteners, Screws, and Bolts: Hot dip galvanized; tamper-proof; security type.

2.3 FINISHES

- A. Stainless Steel: Satin finish, unless otherwise noted.

2.4 COMMERCIAL TOILET ACCESSORIES

- A. Soap Dispenser: Liquid soap dispenser, wall-mounted, surface, with stainless steel cover and horizontal stainless-steel tank and working parts; push type soap valve, check valve, and window gage refill indicator, tumbler lock.
- B. Toilet Paper Dispenser: Refer to drawings for type
- C. Paper Towel Dispenser: Refer to drawings for type.
- D. Combination Towel Dispenser/Waste Receptacle: Refer to drawings for type.
- E. Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.
 - 1. Minimum capacity: 250 seat covers.
- F. Grab Bars: Stainless steel, smooth surface.
 - 1. Standard Duty Grab Bars:
 - a. Push/Pull Point Load: 250 pound-force (1112 N), minimum.
 - b. Dimensions: 1-1/4 inch (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.

- c. Finish: Satin.
 - d. Length and Configuration: As indicated on drawings.
- G. Purse Shelf: Fold-down, with spring-loaded hinge designed to automatically return shelf to vertical position when not in use; 0.03 inch satin-finished stainless steel, with 1/4 inch rolled or 1/2 inch channel edge at shelf front. Type to match existing.
- H. Combination Sanitary Napkin/Tampon Dispenser: Stainless steel, semi-recessed.
 - 1. Door: Seamless 0.05 inch door with returned edges and tumbler lock.
 - 2. Cabinet: Fully welded, 0.03 inch thick sheet.
 - 3. Operation: No charge; no coin slots.
 - 4. Minimum capacity: 15 napkins and 20 tampons.
- I. Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless-steel piano-type hinge, removable receptacle.

2.5 SHOWER AND TUB 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. Color: White.
- C. Robe Hook: Heavy-duty stainless steel, single-prong, rectangular-shaped bracket and backplate for concealed attachment, satin finish.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.

3.2 PREPARATION

- A. Deliver inserts and rough-in frames to site for timely installation.
- B. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.4 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION 10 28 00

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.2 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- B. NFPA 10 - Standard for Portable Fire Extinguishers; 2017, with Errata (2018).

1.3 SUBMITTALS

- A. Product Data: Provide extinguisher operational features.
- B. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- C. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.

1.4 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Extinguishers: Match campus standard. Coordinate with owner
 - 1. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
 - 2. Potter-Roemer: www.potterroemer.com/#sle.
 - 3. Pyro-Chem, a Tyco Business: www.pyrochem.com/#sle.
 - 4. Substitutions as approved by owner.
- B. Fire Extinguisher Cabinets and Accessories: Match campus standard. Coordinate with owner.

1. Kidde, a unit of United Technologies Corp: www.kidde.com/#sle.
2. Larsen's Manufacturing Co: www.larsensmfg.com/#sle.
3. Potter-Roemer: www.potterroemer.com/#sle.
4. Pyro-Chem, a Tyco Business: www.pyrochem.com/#sle.
5. Substitutions as approved by owner.

2.2 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 1. Class: A:B:C type.
 2. Temperature range: Minus 40 degrees F to 120 degrees F.

2.3 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
- C. Cabinet Configuration: Semi-recessed type.
- D. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- E. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- F. Weld, fill, and grind components smooth.
- G. Finish of Cabinet Interior: White colored enamel.

2.4 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, chrome-plated.
- B. Lettering: "FIRE EXTINGUISHER" decal, or vinyl self-adhering, pre-spaced black lettering in accordance with authorities having jurisdiction (AHJ).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.

- B. Verify rough openings for cabinet are correctly sized and located.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions. Install per the AHJ/fire marshals directions.
- B. Date the initial installation on tag.

3.3 MAINTENANCE

- A. Provide a separate maintenance contract for specified maintenance service.

END OF SECTION 10 44 00

SECTION 10 51 13 - METAL LOCKERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal lockers.
- B. Locker benches.

1.2 REFERENCE STANDARDS

- A. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2019a.
- C. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's published data on locker construction, sizes and accessories.
- B. Shop Drawings: Indicate locker plan layout, numbering plan and combination lock code.
- C. Manufacturer's Installation Instructions: Indicate component installation assembly.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect locker finish and adjacent surfaces from damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Metal Lockers:
 - 1. Art Metal Products: www.artmetalproducts.com/#sle.
 - 2. Lyon Workspace Products: www.lyonworkspace.com/#sle.
 - 3. Penco Products, Inc: www.pencoproducts.com/#sle.
 - 4. Republic Storage Systems Co: www.republicstorage.com/#sle.
 - 5. Tennsco Storage; Steel Lockers: www.tennsco.com/#sle.
 - 6. Substitutions as approved by owner.

2.2 LOCKER APPLICATIONS

- A. Employees: Metal lockers, free-standing with matching closed base. Match Existing
 - 1. Width: 12 inches.
 - 2. Depth: 12 inches.
 - 3. Height: 72 inches.
 - 4. Configuration: Single tier.
 - 5. Fittings: Size and configuration as indicated on drawings.
 - 6. Provide sloped top.
- B. Locker Benches: Stationary type; bench top of laminated birch; painted steel pedestals.
 - 1. Accessibility: Comply with ICC A117.1 and ADA Standards.

2.3 METAL LOCKERS

- A. Lockers: Factory assembled, made of formed sheet steel, ASTM A653/A653M SS Grade 33/230, with G60/Z180 coating, stretcher leveled; metal edges finished smooth without burrs; baked enamel finished inside and out.
 - 1. Color: To be selected by Architect.
- B. Sloped Top: 20 gage, 0.0359 inch, with closed ends.
- C. Trim: 20 gage, 0.0359 inch.
- D. Built-In Lock Boxes: Same material as locker, manufacturer's standard size, with padlock hasps, for padlocks provided by Owner.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that prepared bases are in correct position and configuration.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place and secure on prepared base.
- C. Install lockers plumb and square.
- D. Install fittings if not factory installed.
- E. Replace components that do not operate smoothly.

3.3 CLEANING

- A. Clean locker interiors and exterior surfaces.

END OF SECTION 10 51 13

SECTION 13 21 13 - CLEAN ROOM PASS-THRU AIR SHOWER

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Floor Mount Double Door Stainless Steel Pass Thru AIR SHOWER

1.2 RELATED SECTIONS

- A. Division 23 - HVAC; mechanical services and connections.
- B. Division 26 - Electrical; electrical power service and wiring connections.

1.3 REFERENCES

- A. ASTM A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- B. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- C. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- D. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- E. FS 209E - Cleanroom and Workstation Requirements, Controlled Environments.
- F. ISO 146744-1 - Cleanrooms and associated controlled environments Part 1: Classification of air cleanliness

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Cleanroom Pass Through shall be capable of maintaining the following cleanroom performance requirements when installed as follows.
 - 1. Capable of maintaining Class 100 to 10,000 (ISO 5 to ISO 8) conditions in accordance with FS 209E and ISO 146744-1.
 - 2. Capable of maintaining a passive pressure differential of:
 - a. Area outside room: balance condition
 - b. Air lock: 0.05 inch w.g.
 - c. Cleanroom: 0.1 inch w.g.

1.5 SUBMITTALS

- A. 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.
- B. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- C. Closeout Submittals: Provide manufacturer's maintenance instructions that include recommendations for periodic checking and adjustment of cable tension and periodic cleaning and maintenance of all railing and infill components.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in the manufacture of products specified in this section with minimum 10 years documented experience.
- B. Installer Qualifications: Company specializing in performing work of this section with minimum 5 years documented experience.
- C. Preinstallation Meetings: Conduct meeting to verify project requirements, substrate conditions, utility connections, manufacturer's installation instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Do not deliver materials or assemblies to site until installation spaces are ready to receive units.

1.8 SEQUENCING

- A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.
- B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.9 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design Manufacturer: Clean Air Products: <http://www.cleanairproducts.com>

2.2 CLEAN ROOM PASS THRU CABINETS

- A. Floor Mount Double Door Stainless Steel Pass Thru CAP701KD-ST-7072

1. Standard Features

- a. Formed and stitch-welded stainless steel construction
- b. Stainless steel continuous flush-mount hinges
- c. Viewing windows
- d. Urethane door gaskets

2. Materials:

- a. Type 304 #4 finish Stainless Steel (standard)

3. Viewing Windows:

- a. Clear Tempered Safety Glass (standard)

4. Door Latch:

- a. Type 316 stainless steel lever compression door latches (standard)

5. Interlock Hardware:

- a. Magnetic Interlock (Recommended)

6. Mounting:

- a. 6 Piece Stainless Steel Mounting Frame, Standard mount, inside finish both sets

7. Design Options:

- a. Ventilation Couplings

8. Model/Size:

- a. Dimensions: Outside 70.75 inches W x 72 inches D

9. Power Requirement:

- a. 480 Volt, 60 Hz, 3 Phase 4 Wire

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until openings and substrates have been properly prepared.
- B. Verify exact location of clean room pass-thru for installation.
- C. Verify that rough openings and surfaces are ready to receive work.
- D. If opening and substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 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. Provide templates and rough-in measurements as required.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pass- thru, plumb and level. Seal the perimeter of both sides of the opening as required.
- C. Upon completion of installation operate unit and make necessary adjustments.
- D. Connect mechanical services as specified under Division 15.
- E. Connect electrical services as specified under Division 16.

3.4 PROTECTION

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

END OF SECTION 13 21 13

SECTION 21 13 00 – FIRE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gauges.

1.2 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Preaction sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For preaction sprinkler systems.

1. Include plans, elevations, sections, and attachment details.

D. Delegated-Design Submittal: For preaction sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the licensed fire protection engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Sprinkler systems, or BIM model, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved.

- B. Qualification Data: For qualified Installer.
- C. Design Data:
 - 1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations.
- D. Field Test Reports:
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - 2. Fire-hydrant flow test report.
- E. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For preaction sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a licensed fire protection engineer.
 - b. Installer: NICET-certified water-based fire protection systems technician, Level III, minimum

1.8 FIELD CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
1. Notify Construction Manager and Building Manager no fewer than two days in advance of proposed interruption of sprinkler service.
 2. Do not proceed with interruption of sprinkler service without Construction Manager and Building Manager's written permission.
 3. Should the sprinkler system be out of service for more than four hours, the Contractor must provide a fire watch in accordance with NFPA 101 and NFPA 25, "Impairments" Chapter.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with NFPA 13.
- C. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.
- D. Delegated Design: Engage a licensed fire protection engineer to design single interlock preaction sprinkler systems for the sections of the basement, second floor and the entirety of the third floor.
1. Conduct a new flow test to determine the latest pressures available. Perform test during periods of heavy usage of the public water main.
 2. Sprinkler system design shall be approved by authorities having jurisdiction.
 - a. Margin of Safety for Available Water Flow and Pressure: 10 percent, or 10 psi, (whichever is higher), including losses through water-service piping, valves, and backflow preventers.
 - b. Sprinkler Occupancy Hazard Classifications:
 - 1) Offices: Light Hazard Occupancy
 - 2) Toilets: Light Hazard Occupancy
 - 3) Lobby: Light Hazard Occupancy
 - 4) Break Areas: Light Hazard Occupancy
 - 5) Work Areas: Light Hazard Occupancy
 - 6) Airlock: Ordinary Hazard Group I
 - 7) Mechanical: Ordinary Hazard Group I
 - 8) Large Format Press: Ordinary Hazard Group II
 - 9) Iso Clean Room: Ordinary Hazard Group II
 - 10) Lowerator: Ordinary Hazard Group II
 - 11) Waste Destruction: Ordinary Hazard Group II
 3. Minimum Density for Automatic-Sprinkler Piping Design:

- a. Light-Hazard Occupancy: 0.10 gpm over 3000-sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 3000-sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 3000-sq. ft. area.
 - d. Special Occupancy Hazard: As determined by authorities having jurisdiction.
4. Maximum protection area per sprinkler according to UL listing.
5. Maximum Protection Area per Sprinkler:
- a. Office Spaces: 225 sq. ft.
 - b. Storage Areas: 130 sq. ft.
 - c. Mechanical Equipment Rooms: 130 sq. ft.
 - d. Electrical Equipment Rooms: 130 sq. ft.
 - e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

2.2 STEEL PIPE AND FITTINGS

- A. Schedule 40, Black-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Black-Steel Pipe: ASTM A135/A135M or ASTM A795/A795M.
- C. Black-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- D. Uncoated-Steel Couplings: ASTM A865/A865M, threaded.
- E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Cast-Iron Flanges: ASME 16.1, Class 125.
- G. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
 - 1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or EPDM rubber gasket.
 - a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - 2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.
- H. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
- I. Grooved-Joint, Steel-Pipe Appurtenances:
 - 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. Anvil International.
 - b. CPS Products, Inc.
 - c. National Fittings, Inc.

- d. Shurjoint-Apollo Piping Products USA Inc.
 - e. Smith-Cooper International.
 - f. Tyco by Johnson Controls Company.
 - g. Victaulic Company.
- 2. Pressure Rating: 175-psig minimum.
 - 3. Painted, or Uncoated Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

- A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- B. Pressure Rating:
 - 1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
- C. Body Material: Cast or ductile iron.
- D. Size: Same as connected piping.
- E. End Connections: Flanged or grooved.
- F. Automatic (Ball Drip) Drain Valves:
 - 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. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco by Johnson Controls Company.
 - 2. Standard: UL 1726.
 - 3. Pressure Rating: 175-psig minimum.
 - 4. Type: Automatic draining, ball check.
 - 5. Size: NPS 3/4.
 - 6. End Connections: Threaded.
- G. Iron Butterfly Valves with Indicators
 - 1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
 - 2. Minimum Pressure Rating: 175 psig.
 - 3. Body Material: Cast or ductile iron.
 - 4. Seat Material: EPDM.
 - 5. Stem: Stainless steel.
 - 6. Disc: Ductile iron.
 - 7. Actuator: Worm gear or traveling nut.
 - 8. Supervisory Switch: Internal or external.

9. Body Design: Grooved-end connections.

H. Check Valves

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

I. Iron OS&Y Gate Valves

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron.
5. Wedge Seat: Cast or ductile iron.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

J. Trim and Drain Ball Valves

1. Pressure Rating: 175 psig
2. Body Design: Two piece.
3. Body Material: Forged brass or bronze.
4. Port size: Full or standard.
5. Seats: PTFE.
6. Stem: Bronze or stainless steel.
7. Ball: Chrome-plated brass.
8. Actuator: Handlever.
9. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
10. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

2.4 AIR VENT

A. Automatic Air Vent:

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. AGF Manufacturing, Inc.
 - b. CLA-VAL.
 - c. Engineered Corrosion Solutions.
 - d. Metraflex Company (The).

- e. Val-Matic Valve & Manufacturing Corp.
- 2. Description: Automatic air vent that automatically vents trapped air without human intervention.
- 3. Standard: UL listed or FM Global approved for use in preaction fire sprinkler systems.
- 4. Vents oxygen continuously from system.
- 5. Float valve to prevent water discharge.
- 6. Minimum Water Working Pressure Rating: 175 psig.

2.5 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:

- 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. AGF Manufacturing, Inc.
 - b. Anvil International.
 - c. National Fittings, Inc.
 - d. Shurjoint-Apollo Piping Products USA Inc.
 - e. Tyco by Johnson Controls Company.
 - f. Victaulic Company.
- 2. Standard: UL 213.
- 3. Pressure Rating: 175-psig minimum.
- 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
- 5. Type: Mechanical-tee and -cross fittings.
- 6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
- 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
- 8. Branch Outlets: Grooved, or threaded.

B. Flow Detection and Test Assemblies:

- 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. AGF Manufacturing, Inc.
 - b. Reliable Automatic Sprinkler Co., Inc. (The).
 - c. Tyco by Johnson Controls Company.
 - d. Victaulic Company.
- 2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- 3. Pressure Rating: 175-psig minimum.
- 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
- 5. Size: Same as connected piping.
- 6. Inlet and Outlet: Threaded or grooved.

C. Sprinkler Inspector's Test Fittings:

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. AGF Manufacturing, Inc.
 - b. Triple R Specialty.
 - c. Tyco by Johnson Controls Company.
 - d. Victaulic Company.
 - e. Viking Corporation.
2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

D. Adjustable Drop Nipples:

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. Aegis Technologies, Inc.
 - b. CECA, LLC.
 - c. CPS Products, Inc.
 - d. Merit Manufacturing.
2. Standard: UL 1474.
3. Pressure Rating: 250-psig minimum.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

2.6 SPRINKLERS

- 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. Globe Fire Sprinkler Corporation.
 2. Reliable Automatic Sprinkler Co., Inc. (The).
 3. Tyco by Johnson Controls Company.
 4. Venus Fire Protection Ltd.
 5. Victaulic Company.
 6. Viking Corporation.
- B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
- C. Pressure Rating for Residential Sprinklers: 175-psig maximum.
- D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.
- E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

F. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

G. Sprinkler Finishes: Chrome Plated or Bronze

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel one piece, flat.

I. Sprinkler Guards:

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. Reliable Automatic Sprinkler Co., Inc. (The).
 - b. Tyco by Johnson Controls Company.
 - c. Victaulic Company.
 - d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicators:

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. ADT Security Services, Inc.
 - b. McDonnell & Miller.
 - c. Potter Electric Signal Company, LLC.
 - d. System Sensor.
 - e. Viking Corporation.
 - f. WATTS.
2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.

6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

C. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell International company.
 - b. Kennedy Valve Company; a division of McWane, Inc.
 - c. Potter Electric Signal Company, LLC.
 - d. System Sensor.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.8 PRESSURE GAUGES

- 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. AGF Manufacturing, Inc.
 2. AMETEK, Inc.
 3. Ashcroft Inc.
 4. Brecco Corporation.
 5. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
- D. Pressure Gauge Range: 0- to 250-psig minimum.
- E. Label: Include "WATER" label on dial face.

2.9 SLEEVES

- A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- B. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, with plain ends and integral welded waterstop collar.

2.10 SLEEVE-SEAL SYSTEMS

- A. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
- B. Designed to form a hydrostatic seal of 20 psig minimum.
- C. Sealing Elements: EPDM-rubber, High-temperature-silicone, or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
- D. Pressure Plates: Carbon steel, Composite plastic, Stainless steel, or Stainless steel, Type 316.
- E. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 633, Stainless steel, or Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 PREPARATION

- A. The design team fire protection engineer must assess the adequacy of the existing water supply. The design team fire protection engineer must perform water supply flow testing of fire hydrants and/or fire pumps. If the hydraulic data is less than one year old and is available from the local jurisdiction, the design team fire protection engineer must verify the locations involved as well as the quality and accuracy of the data. The required fire water flows and pressures for buildings must comply with the requirements in NFPA 13, 14, and 20.
- B. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- C. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Install shutoff valve, check valve, pressure gauge, and drain at connection to existing preaction sprinkler system riser.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
 - 2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
- B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

- C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- D. Install return bends for all pendent sprinklers.
- E. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gauges on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gauges with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they are not subject to freezing.
- N. Fill sprinkler system piping with water. Hydrostatically test the sprinkler system at 200 psi for 2 hours.
- O. Install sleeves for piping penetrations of walls, ceilings, and floors.
- P. Install sleeve seals for piping penetrations of concrete walls and slabs.
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.4 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls. (Holes shall be sized such that the diameter of the holes is nominally 2 inches larger than the pipe for pipe 1-inch nominal to 3 1/2-inch nominal and 4 inches larger than the pipe for pipe 4-inch nominal and larger).
 - 1. Sleeves are not required for core-drilled holes.

- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal space outside of sleeves in slabs and walls without sleeve-seal system.

3.5 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.6 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. Install valves in vertical position for proper direction of flow, in main supply to system.
 - 2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
- E. Air Vent:
 - 1. Provide at least one air vent at high point in each preaction sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping.
 - 2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

3.7 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. UL-listed or FM-approved flexible sprinkler hose fittings and their anchoring components intended for use in installations connecting the sprinkler system piping to sprinklers is permitted to be installed. When installed and supported by suspended ceilings, the design team fire protection engineer must certify in writing that the ceiling meets ASTM C635, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings, and will be installed in accordance with ASTM C636, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

3.8 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

3. Coordinate with fire-alarm tests. Operate as required.
4. Verify that equipment hose threads are same as local fire department equipment.

- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 PIPING SCHEDULE

- A. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
- B. Standard-pressure, preaction sprinkler system, NPS 2" and smaller, shall be the following:
 1. Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
- C. Standard-pressure, preaction sprinkler system, NPS 2-1/2" and larger, shall be the following:
 1. Schedule 40 or Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.12 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
 1. Rooms without Ceilings: Upright or Pendent sprinklers.
 2. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers as indicated.
 3. Wall Mounting: Sidewall sprinklers.
 4. Spaces Subject to Freezing: Sidewall, dry sprinklers.
 5. Special Applications: Extended-coverage and quick-response sprinklers where indicated.
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
 1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
 3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
 4. Upright and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

END OF SECTION 21 13 13

SECTION 22 05 00 - BASIC PLUMBING MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Requirements of this Section are applicable to work in Division 22.
- B. Contract Documents:
 - 1. Unless otherwise modified, drawings and general provisions of the Contract, including provisions of General Conditions, and Division 01 govern work under Division 22.
 - 2. Contract drawings for plumbing work are diagrammatic, intended to convey scope and general arrangement.
 - 3. Refer questions involving document interpretation or discrepancies to Contract Officer's Representative (COR) for review and direction.
 - 4. Correct faulty work due to resolving discrepancies without proper approval.
 - 5. Specifications establish quality of materials, equipment, workmanship and methods of construction.
 - 6. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.
- C. Scope:
 - 1. The work in Division 22 includes furnishing and installing the plumbing work complete and ready for satisfactory service.
 - 2. Requirements specified govern work in all sections of Division 22.
 - 3. Some of the work described in this Section is also applicable to the scope of Divisions 25 and 26.

1.2 RELATED DIVISIONS

- A. Division 01 - General Requirements
- B. Division 03 - Concrete
- C. Division 05 – Metals
- D. Division 07 - Thermal and Moisture Protection
- E. Division 08 - Openings
- F. Division 09 - Finishes
- G. Division 10 – Specialties
- H. Division 21 - Fire Suppression
- I. Division 23 - Heating, Ventilating, and Air Conditioning

J. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with regulations of NFPA, District, GPO standards and other applicable codes and regulations.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- C. Material and Equipment Requirements:
 - 1. Use products of one manufacturer where two or more items of same kind of equipment are required.
 - 2. Materials and equipment shall have a record of one-year successful field use.
 - 3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
 - 4. Only the manufacturer's equipment upon which the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
 - 5. Basis of Design Products: Where the Specifications or Drawings name a specific manufacturer's product accompanied by the words "Basis of Design," including make or model number or other designation, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Naming of a Basis of Design product is intended to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. The drawings indicate the general size, configuration, location, connections and/or support for equipment or systems specified with relation to the other building systems.
- D. Workmanship:
 - 1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 - 2. Coordinate work and cooperate with other trades to facilitate execution of work.
- E. Coordination with Other Trades:
 - 1. Contractor shall give full cooperation and coordination with other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 - 2. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordination adjacent work.
- F. Asbestos or asbestos-containing materials shall not be utilized or allowed on this project. The Contractor shall be rigorous in assuring that all materials, equipment, systems, and components do not contain asbestos. Any deviations from this exclusion shall be remedied at the Contractor's expense without regard to prior submittal approvals.

- G. Access: The Contractor shall specifically consider all materials and equipment installations and shall coordinate with the work of all trades to ensure easy and unobstructed accessibility of all systems for operations, maintenance, repairs, and replacement. Installation of all specified materials and equipment including but not limited to, equipment, supports, pipe, electrical conduit and controls shall be in a manner which will allow complete unobstructed access to all panels, access doors, filter racks, control boxes, controls actuators, sensors, valves, tube bundles and all other items requiring access for operations or maintenance. All items such as controls, actuators and valves which require servicing or manual operations for system use shall be located such as to be accessible without standing on other equipment, whenever it is possible or practical. Any installation of new equipment or materials which causes problems related to access of new /or existing/ equipment shall be disapproved by the COR and re-accomplished by the Contractor.
- H. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- I. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

1.4 ACTION SUBMITTALS

- 1. Manufacturer's technical product data, installation instructions and description of accessories for each type to be used and system designation:
- 2. Certificate of completion of cleaning of water systems.
- 3. Paint primer /and finish coat/.
- 4. Access panels.
- 5. Concrete compressive strength test.
- 6. Motors and power factor correction capacitors (submit under section specifying related equipment).
- 7. Layout drawings for equipment supports.
- 8. Charts for shutoff valve locations.
- 9. Operating and maintenance manuals.
- 10. Statement of field instruction completion.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. References:
 - 1. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.

2. Refer to applicable contract drawings and specifications pertaining to other Divisions for conditions affecting work.

B. Definitions: The following are definitions of terms and expressions used in Division 22:

1. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
2. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
3. "Directed" - directed by COR.
4. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
5. "Exposed" - not concealed.
6. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
7. "Indicated" - indicated in Contract Documents.
8. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
9. "Removable" - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
10. "Review" - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

C. Refer to Division 01, "References" for additional definition of terms.

1.8 OPERATION AND MAINTENANCE REQUIREMENTS

- A. Provide Operation and Maintenance Manuals in accordance with Section 01 78 23, "Operation and Maintenance Data".

1.9 WARRANTY

- A. Deliver to the COR certificates of equipment warranty extending beyond the guarantee period.

PART 2 PRODUCTS

2.1 PAINTING

- A. Schedule:

SURFACE	COATS	MATERIAL
Concealed Piping, etc.	1	Primer equivalent to Glidden Devguard 4160
Outdoor Metal, Mill Galvanized	1	Inorganic coating equivalent to Crown 7007VG
Outdoor Metal, Other	1	Primer: Equivalent to Glidden Devgurad 4160

	2	Enamel: Equivalent to Glidden Devflex 4216
--	---	--

2.2 ACCESS PANELS

- A. Access panel products are specified in Division 08.

2.3 FLASHING

- A. Flashing Material:
 - 1. 16-ounce per square foot soft sheet copper.
- B. Counterflashing: 26-gage galvanized steel or 16-ounce per square foot soft sheet copper.

2.4 CONCRETE WORK

- A. Compressive Strength: As specified in Division 03 30 00.
- B. Reinforcing Steel: Yield strength as determined by structural design.
- C. Grout: As specified in Division 05 12 00.

2.5 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

- A. References, Characteristics and Ratings:
 - 1. Refer to Electrical Division for requirements of electrical work including starters specified in the Plumbing Division.
 - 2. Provide motors and other equipment requiring electrical power or control service suitable for the electrical characteristics indicated on the Electrical Drawings.
 - 3. Horsepower indicated is for manufacturer's equipment upon which the specification is based. Submit proposed deviations from these ratings for review by the COR. Pay costs incurred by deviations, which are permitted.
 - 4. Provide motor rated for 200 volts for 208-volt service. Provide 230 and 460-volt rated motors for 240 and 480-volt service.
 - 5. Brake horsepower at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.15 service factor except where other limits are stated for certain equipment, i.e., pumps, the maximum load percentage shall be as stated under that equipment times the 1.15 service factor.
 - a. For motors operating in ambient conditions of 122 degrees F or above, service factor shall be 1.00.
- B. Overload Protection:
 - 1. Protect each motor, either individually mounted or in unitary equipment, with overload devices such as fuses, thermal cutouts, or thermal protectors installed in each ungrounded

- conductor serving each motor. Mount these overload devices in the motor controller or in a control panel in unitary equipment.
2. For equipment that requires the use of fuses, provide the proper size and type of fuses mounted on accessible fuse blocks, integral to the equipment, wired in accordance with applicable codes.
- C. Construction:
1. Construct motors in accordance with NEMA Standard Publication MG-1, latest edition, and the applicable IEEE standards.
 2. Frame sizes in accordance with NEMA Standard MG-1 and MG-13, latest editions.
 3. Comply with IEEE 841 for severe duty motors.
 4. Starting torque, NEMA Design B, 2-4 percent slip.
 5. Starting (locked rotor) kVA as required by the driven equipment. On motors with a locked rotor indicating code letter of "F" or higher, the manufacturer shall notify the electrical contractor for circuit breaker adjustment in accordance with Division 26, "Electrical."
 6. Indoor, General Use: Open dripproof construction, 1.15 service factor.
 7. Outdoor, Exposed Motor: Totally enclosed fan cooled construction, 1.15 service factor, stator windings totally encapsulated having non-hygroscopic insulation approved for outdoor use, and double shielded bearings.
 8. Rotor: Random-wound, squirrel cage.
- D. Insulation: NEMA Insulation Class B for operation in 40 degrees C ambient; except NEMA Premium efficient motors shall be NEMA Class F insulation with horsepower based on Class B rise.
- E. Where motors operate in a maximum ambient temperature above 40 degrees C, provide motors suitably designed for the ambient temperature indicated, employing a different class of insulation or having a change in frame size, i.e., the ambient temperature plus motor full load temperature rise plus 10 degrees C shall not exceed the temperature rating of the insulation system.
- 2.6 HANGER ATTACHMENT - Application and Type
- A. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.
 - B. Concrete (Existing): Double plated expander type anchors. Phillips, Hilti or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.
 - C. Precast Concrete Plank: Drill hole through plank; bolt hanger rod to 4-by-4-by-1/8-inch steel plate on top of plank.
 - D. Steel Beams: Iron or steel beam clamps.
 - E. Brick or Block Walls: Brackets fastened with self-drilling anchors or toggle bolts, light duty; or through bolts with backplates, heavy duty.
- 2.7 SLEEVES AND ESCUTCHEON PLATES

- A. Coordinate with Section 07 84 00, "Firestopping" for penetration firestopping installed in fire-resistance rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
- B. Sleeves for Piping and Conduits - Material and Application:
 - 1. Galvanized Standard Weight Steel Pipe:
 - a. Floors where pipes will be exposed above the floor.
 - b. Interior concrete walls
 - c. Interior masonry walls.
 - 2. Galvanized Standard Weight Steel Pipe with Anchor Flange Welded to Perimeter:
 - a. Exterior concrete walls.
 - b. Exterior masonry walls.
 - c. Roof vent stacks, which are flashed into stack terminal or terminal fitting.
 - 3. 22-Gage Galvanized Steel:
 - a. Stud partitions.
 - b. Suspended plaster and gypsum board ceilings.
 - 4. 22-Gage Galvanized Steel or Moisture Resistant Fiber or Plastic, equipped with temporary centering caps or bottom flanges secured to forms before concrete is poured: Concrete floors where pipes will be concealed above the floor.
 - 5. Galvanized Standard Weight Steel Pipe or Galvanized Cast Iron Pipe, with Integral Membrane Clamping Ring and Brass or Cadmium Plated Bolts:
 - a. Floors with membrane waterproofing.
 - b. Roofs with membrane waterproofing.
- C. Escutcheon Plates for Piping: Chromeplated brass.
- D. Sealant:
 - 1. One part polysulfide, equivalent to Pecora Synthacaulk GC24 or polycarbonate equivalent to Proseal 34 for general use.
- E. Grout:
 - 1. Non-shrink, recommended for interior and exterior sealing openings in non-fire rated walls or floors.
 - 2. ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic cement grout.
 - 3. Design Mix: 5,000-psi, 28-day compressive strength.
 - 4. Premixed and factory packaged.

PART 3 EXECUTION

3.1 PAINTING

- A. Paint miscellaneous ironwork which is not copper, galvanized, aluminum, and stainless steel.
- B. Touch-up scratches and marred places on factory painted equipment to match finish.
- C. Paint outdoor piping that is not copper, galvanized, aluminum, stainless steel, or plastic.
- D. Remove grease, scale, rust, and dirt from work to be painted under this or other parts of the specification.
- E. Do not paint when surfaces are damp, exposed to sun, or when temperature is below 50 degrees F.
- F. Do not paint bearings, lubrication fittings, gages, brass trim, nameplates, or other elements where such application would interfere with operation and maintenance of equipment.
- G. Wash galvanized surfaces with pretreating preparations as directed by paint manufacturer.
- H. Omit primer if equipment has factory shop coat. Finish coats must be compatible with shop coat.

3.2 ACCESS PANELS

- A. Furnish and access panels or doors that are indicated or required for access to control devices and to concealed plumbing and associated electrical devices which may require future inspection, repair or adjustment; and elsewhere as required by applicable codes. Installation of panels is specified in Division 08.
- B. Use ceiling element as access panel in suspended metal pan, lay-in panel, and accessible tile ceilings.
- C. Attach a 1/4-inch diameter color-coded aluminum tag to exposed grid tees or ceiling elements used as access panels and recessed pan doors. Coordinate identification with Section 22 05 53, "Identification for Plumbing Piping and Equipment."
- D. Acoustic Tile Ceiling: Fit frame with anchoring devices for suspension system. Recessed pan type door with acoustic tile facing.

3.3 FLASHING

- A. Flash vent stacks, conduits, and pipes projecting through roof or outside walls. /Make watertight seal to roof material and pipe or conduit. Turn vent stack flashing down into stack tight against inside of pipe being careful not to block vent piping with flashing.
- B. Protect sleeve packing and flashing joints with counterflashing. Solder or weld counterflashing to pipe or conduit. Clean joint and coat with zinc dust paint.

3.4 CONCRETE WORK

- A. Location: Equipment housekeeping pads, and where indicated under plumbing work.
- B. Perform work in accordance with Division 03 conformance to American Concrete Institute Standard ACI 301-72, Specifications for Structural Concrete for Buildings/.
- C. Bond new work to existing concrete, by approved adhesive or by roughing existing surface to expose aggregate uniformly, then cleaning surface. Key new pads, piers, curbs, and pedestals to concrete floors using expansion bolts.
- D. Bevel exposed vertical and horizontal edges 3/4-inch.
- E. Install grout according to manufacturer's recommendations.
- F. Testing: Test concrete as specified under Division 03.

3.5 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

Align motor, drives, and driven equipment to avoid excessive strain or wear.

3.6 HANGER ATTACHMENT

- A. Select and install structural attachments for hangers supporting pipes, conduit, and equipment adequately for stresses to which they may be subject and for proper distribution of load to building structural members.

3.7 SLEEVES AND ESCUTCHEON PLATES

- A. Sleeves are not required for core-drilled holes except where sleeves are specified and required to extend above the floor.
- B. Sleeve are not required for floor slabs on-grade.
- C. Install sleeves for pipes and conduits passing through roofs, floors, plaster ceilings, gypsum board ceilings, walls, partitions, structural members, and other building parts. Install sleeves in time to permit construction progress as scheduled.
- D. Install sleeves with length to pass through full thickness of construction.
- E. Provide 1/2-inch minimum clearance between sleeve and conduit, pipe, or covering. Center conduit or pipe in sleeve unless otherwise indicated.
- F. Insulation thickness specified for use through sleeves requiring vermin proofing shall be as specified but not less than 1-inch minimum thickness. Refer to Section 22 07 00, "Plumbing Insulation."
- G. Install ends of sleeves flush with finished wall surfaces.
- H. Cut sleeves to length for mounting flush with both surfaces except, extend floor sleeves for exposed conduits and pipes 2-inch above finished floor.

- I. Reinforce sleeves temporarily, if necessary, to preserve accurate shape without distortion during construction.
- J. Grout sleeves in concrete floors, concrete roof slabs and concrete walls into building structure to make joint watertight.
- K. Install escutcheon plates for pipes and conduits at floors, ceilings, walls, and partitions in finished areas unless otherwise indicated:
 - 1. Fit escutcheons around insulation, uninsulated pipe, or conduit.
 - 2. Outside diameter shall cover sleeve.
 - 3. Where sleeve extends above finished floor, cover sleeve extension with escutcheon.
 - 4. Install one-piece escutcheons for new piping.
 - 5. Install split-plate escutcheons on existing piping.
- L. Pack annular space between sleeve and conduit or pipe and voids between building construction and conduit, pipe, or sleeves as follows:
 - 1. Firestop equal to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, for the following sleeve locations:
 - a. Where vermin control is indicated.
 - b. Roof and walls with waterproofing.
 - 2. For the following locations, pack annular space between sleeve and conduit or pipe and voids between building construction and conduit or pipe sleeves with industrial felt fire material equal to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, or code approved firestopping foam, caulk, or putty that meets ASTM E-814 with UL classification firestopping sealant as specified in Division 07. Sealants shall not contain toxic or flammable solvents and shall not produce toxic or flammable out-gassing during any stage of application, curing, drying or fire conditions:
 - a. Floors.
 - b. Smoke barriers.
 - c. Fire rated walls.
 - d. See Section 22 07 00, "Plumbing Insulation," for fire stop insulation on pipes through sleeves.
- M. Vermin Control: Provide vermin control for conduits or pipes passing through ceilings, walls, and partitions.
- N. Prime surfaces prior to caulking to obtain good adhesion where recommended by sealant manufacturer.
- O. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - 1. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.8 CONTRACTOR'S INSTALLATION DRAWINGS

- A. These drawings shall not be construed as shop drawings that require review and action by the COR.
- B. Submit, prior to installation of plumbing systems, six copies of composite working drawings prepared in coordination with other trades at a scale not less than $\frac{1}{2}$ inch = 1 foot, clearly showing how work is to be installed in relation to the work of all trades. Contractor shall assist in working out congested space conditions to make a satisfactory adjustment. Drawings shall show the work of all trades (ductwork, conduit, piping, plumbing, lights, equipment, sprinklers, electrical work, etc.) exposed and concealed, including existing mechanical, plumbing, fire protection, and electrical services, coordinated with each other and with the structure. Drawings shall be submitted and bear the COR's review stamp before any materials are ordered or fabricated.
- C. Work installed before coordinating with other trades or as to cause any interference with work of other trades shall be changed by the Contractor to correct the conditions at their expense.
- D. Drawings shall show existing services where clearances for access are to be maintained.
- E. Relocate existing work or modify location of new work as required to maintain required access and code clearances.

3.9 PROJECT RECORD DOCUMENTS

Maintain at the site one set of black or blue line on white prints of drawings, copies of specifications, addenda, shop drawings reviewed by COR, change orders and other modifications in good order and marked in red ink to record changes made during construction. Deliver these in final complete form to the COR upon completion of work.

3.10 MATERIAL AND EQUIPMENT LIST

- A. Submit for COR's review a list of subcontractors' and manufacturers' names for items proposed for the work within 30 days after award of the contract.
- B. Failure to submit list or name manufacturers acceptable to COR within time limit will result in COR selecting a list of manufacturers, and selection shall be binding upon Contractor.

3.11 SHOP DRAWINGS AND DESCRIPTIVE DATA

- A. Submit electronic copies, in accordance with Division 01, of manufacturer's shop drawings and descriptive data.
- B. Establish that the physical and functional character of each item including, size, type and required service access is suited for its intended location and use.
- C. Coordinate drawings and data before submitting and certify that provisions of the contract documents have been met.
- D. Call attention, in writing, to deviations from contract requirements.

- E. Do not fabricate, deliver to site, or install items requiring shop drawing review, until the review has been completed by the COR and the shop drawing has been marked to indicate "No Exception Noted" or "Make Corrections Noted."
- F. Specifically identify pertinent project data on the shop drawings.
- G. Include Operation and Maintenance Data.
- H. Use only final or corrected drawings and data for construction.

3.12 SITE EXAMINATION

- A. Failure to visit site and become familiar with local conditions prior to bidding will not relieve the Contractor of their responsibility for complying with the Contract Documents.

3.13 PERMITS

- A. Obtain and pay for the required permits.
- B. CUTTING AND PATCHING
- C. Unless otherwise directed, do cutting and patching. Repair damaged fireproofing and waterproofing to original or better condition.
- D. Do not cut walls, floors, reinforced concrete or structural steel without COR's permission. Install services without affecting reinforcing steel.
- E. In precast concrete plank, drill holes with a carboloy tipped drill. Follow instructions of plank manufacturer. Cut no reinforcing bars.

3.14 CLEANING UP

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place debris in containers and promptly remove them from the Government's property.

3.15 DEMOLITION

- A. Terminate service and utility lines in accordance with local laws, ordinances, rules and regulations.

3.16 WORK IN EXISTING BUILDINGS

- A. Conditions of Occupancy:

1. This building will be occupied during the life of this contract. Execute work in a manner to impose minimal interference with the normal functioning of the building and its occupants. When interference is unavoidable, schedule work 14 days in advance with the COR.
 2. Make temporary connections where necessary to maintain uninterrupted electrical and plumbing service.
 3. Provide adequate protection for the building, its contents, and occupants.
 4. Perform work as quietly as possible to avoid unnecessary disturbance. Unusual precaution may be necessary in the conduct of work in some areas to achieve satisfactory compliance.
 5. Coordinate with COR to perform masonry demolition or other work producing high noise levels, dust, or hazards to occupants in occupied areas.
 6. Comply with regulations of COR pertaining to circulation, sanitation, and behavior of Contractor's personnel.
 7. Also see Division 01, General Requirements".
- B. Interruption of Existing Water Service and Sanitary/Vent Service:
1. Do not interrupt water and sanitary/vent service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary water and sanitary/vent service according to requirements indicated:
 - a. Notify COR no fewer than 14 days in advance of proposed interruption of water service.
 - b. Do not interrupt water service without COR's written permission.
- C. Temporary Use of Elevator:
1. Use only the elevator(s) designated by the COR for Contractor's use in accordance with the COR's instructions for use.
 2. Protect elevator cab with temporary wood lining on floors, walls, and ceiling throughout period used. Upon completion of construction, restore cab to substantially equal condition as existed prior to Contractor's use. Operate elevator(s) during period complying with regulations governing usage.
- D. Field Office, Storage, and Loading Facilities:
1. Provide office and storage facilities where designated by the COR.
 2. Provide adequate furnishings including file space, lighting, telephone, and heat where necessary.
 3. Use only those toilet facilities designated by the COR for use by Contractor's personnel.
 4. Store equipment and materials in areas designated by COR in a manner which will not (a) cause concentrations of weight potentially damaging to building structure, (b) impede normal building traffic, or (c) be a hazard to occupants.
 5. Use only the entrance designated by the COR for delivery and removal of materials. Schedule deliveries and removals with the COR in advance. Unscheduled traffic must give precedence to Government's usage. Do not impede access through doorways and corridors with materials, containers, or parked conveyances.
 6. Use only rubber wheeled wheelbarrows, dollies, or carts over finished floors.
 7. Keep office, storage, and loading areas neat and clean.
- E. Barricades:
1. Erect temporary barriers for protection of occupants, building, and building contents.

2. Where partitions separating occupied areas must be cut, close hole with tight fitting temporary plywood closure panel, 1/2-inch minimum thickness, to form visual and acoustical barrier.
3. Protect exposed holes in floors in accordance with applicable codes and regulations.
4. Enclose dust-producing operations with plastic sheets or drop cloths to prevent the spread of dust into occupied areas. Maintain a negative pressure environment relative to the surrounding spaces:
 - a. Take the necessary precautions to prevent the spread of dust and dirt through the existing HVAC system, including outdoor intakes. Protect new and existing return and exhaust air openings.

F. Alterations:

1. Cut, alter, remove or temporarily remove and replace existing work necessary for installation of plumbing and associated electrical work. Maintain the necessary clearances for accessibility or compliance with code around existing equipment, devices, etc., that are to remain.
2. Verify dimensions of existing building elements pertaining to the installation of new work to assure physical compatibility prior to fabrication or installation.
3. Where the installation of new services or the extension of existing services requires cutting of existing floors, walls, partitions, etc., check for the presence of existing fire suppression, plumbing, mechanical and electrical services within or immediately beneath construction and exercise necessary precautions to prevent damage to the service or injury to personnel due to contact with same. Where practical, temporarily disconnect such existing service during the cutting operation. Schedule such outages in service with the COR, 14 days in advance.

G. Furnishings and Equipment:

1. Identify, to the COR at the time work is scheduled, movable furnishings and equipment which interfere with the progress of the work.
2. Protect remaining furnishings and equipment in work area, both movable and fixed, with drop cloths, batting or other means to prevent damage.

H. Removal of Materials and Equipment:

1. Remove promptly from the site, materials and equipment specified to be removed and not reinstalled or stored.
2. Unless otherwise indicated, removal of pipes, and equipment includes removal of accessories such as hangers, piping connections, junction boxes, starters, etc. and all abandoned and non-operational plumbing system components within limits of the contract. Remove to source or, if concealed, to point of concealment, connections to plumbing equipment required to be removed or disconnected. Terminate connections behind finished surfaces and, if subject to movement, clear of building construction. Cap connections extending from piping remaining in service and provide valves at caps for pressure piping. Contractor shall mark all components to be removed and obtain confirmation from GPO Engineering Operations prior to demolition.

- I. Roof Protection: The Contractor shall provide full temporary roof protection for the building's existing roof system during all construction which involves construction on the facility roof. Protection shall consist of full area mats, plywood and other protection devices. No construction shall be performed on areas without protection devices in place. No regular traffic directly on the existing roof shall be permitted. Provide roof guard protection pads for all roof top equipment

installed under this contract. Pads shall be compatible with the existing roof system. Roof guard pads shall be 3/4-inch thick, textured surface non-skid type. Construction shall be rubber or neoprene materials. Pads shall be minimum 4-by-5 feet units and shall be secured to the existing roof with compatible adhesives. Pad surface shall be heavy duty, damage resistant. Provide a minimum of 300 square feet of pad for each piece of roof top equipment. Install pads immediately adjacent to equipment; at all regular maintenance locations; and probable walkways to the equipment. Install and secure in accordance with the manufacturer's instructions.

J. Connections to Existing Systems:

1. Connect to existing systems as indicated.
2. Obtain permission from COR 14 days in advance if outage of service is necessary to make connections. See the Article titled, "Outages."
3. Repair insulation damaged at points of connection. Restore integrity of vapor barriers and surface finish.

3.17 PROTECTION

- A. Protect plumbing and associated electrical material and equipment from the elements or other injury as soon as delivered on premises. Protect plumbing fixtures as soon as they are set. Cover water closets and post notices prohibiting their use:
1. Accept in original packaging.
 2. Store in clean, dry space.
 3. Protect from dirt, water, construction debris, and traffic.
 4. Handle in accordance with manufacturer's written instructions.
- B. Cap or plug openings in equipment, piping, and conduit systems, to exclude dirt and other foreign material. Do not use rags, wool, cotton, paper, waste or similar materials for plugging.
- C. Existing components of the building and its systems shall be protected from damage. Any damage to these components shall be repaired or replaced to the satisfaction of the COR. Special care shall be taken with regards to insulation on existing piping and ductwork. Damaged insulation shall be replaced so that the vapor barrier and insulating characteristics of the material match those prior to damage taking place.

3.18 CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior are free of foreign matter.
- B. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- C. Thoroughly clean plumbing fixtures using non-scratching cleaners. Polish chromium plated work.
- D. Leave systems clean, and in complete running order.

- E. Disinfect potable water systems as prescribed by local code. Take precautions to avoid use of fixtures during disinfecting period. The disinfecting shall be performed by water treatment company selected for water treatment under Section 23 25 00 - "Water Treatment Systems".
- F. RO Water Systems:
 - 1. After satisfactory completion of pressure tests; clean and disinfect the system.
 - 2. Remove any submicron filter cartridges from their housings and install 5-micron filter cartridges.
 - 3. Protect any equipment which may be damaged by disinfection solution, by removal or bypass.
 - 4. Fill the system with a solution recommended by the RO water system manufacturer.
 - 5. Recirculate the solution through the system and from each outlet in accordance with the equipment manufacturer's instructions and recommendations.
 - 6. Drain disinfection solution from system.
 - 7. Flush system with RO water to insure all disinfection solution has been removed.
 - 8. Remove any carbon filters and install new carbon filters.
 - 9. Replace any equipment and submicron filters, and fill system with RO water.

3.19 ASBESTOS

Should material resembling asbestos-containing materials be encountered during execution of work, immediately notify COR for instructions before proceeding.

3.20 EQUIPMENT SUPPORTS

- A. Provide equipment supports consisting of platforms, concrete pads, structural members, hangers, rods, racks, and incidental materials.
- B. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas.
- C. Concrete Equipment Pads:
 - 1. Provide concrete pads not less than 4 inches high and projecting not less than 3 inches on all sides beyond equipment for floor mounted equipment.
 - 2. Place anchor bolts in steel pipe sleeves, with a plate at bottom end of sleeve to hold bolts.
 - 3. Grout between base plate and foundation.
- D. Floor Mounted Stands: Construct with structural steel members or steel pipe and fasten with flanges bolted to floor.
- E. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.
- F. Wall Mounted Platforms: Construct with steel brackets.

3.21 OPERATING AND MAINTENANCE MANUAL

- A. Furnish manual bound and indexed containing:
 - 1. Brief description of each system and components.
 - 2. Starting and stopping procedures.
 - 3. Special operating instructions.
 - 4. Routine maintenance procedures.
 - 5. Schedule for periodic servicing and lubrication.
 - 6. Manufacturers' printed operating and maintenance instructions, parts lists, illustrations and diagrams.
 - 7. Manufacturers' Data Report Form U-1 certifying code compliance for equipment specified to be constructed in accordance with ASME Code for Unfired Pressure Vessels.
 - 8. One final or corrected reviewed copy of each shop drawing and Contractor's drawings.
 - 9. One copy of each wiring and piping diagram.
 - 10. One reviewed copy of certified test reports.
 - 11. Water balancing report.
 - 12. Product warranty information.
- B. Submit to COR for review at least 30 days prior to date it is expected system will be turned over to the Government.
- C. After review by COR, submit three copies to COR and one to Engineer of Record.

3.22 FIELD INSTRUCTION

- A. Provide operating and maintenance staff demonstrations and training in accordance with Section 01 79 00, "Demonstration and Training":
 - 1. Provide a walking tour, demonstrating all new plumbing equipment, system layout, routing and labeling.
- B. Upon completion of work, instruct Government's representatives in the proper operation and maintenance of the plumbing systems.
- C. Instruction periods specified below shall be in addition to instructions specified for certain items elsewhere in the specifications.
- D. Instructions shall be given by persons expert in the operation and maintenance and shall be for a period of not less than 1 eight-hour days.
- E. Prepare statement(s) for signing by Government's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to COR.

3.23 OUTAGES

- A. The purpose of this article is to establish standard procedures for requesting an outage for plumbing, electrical, or operational systems or services associated with the building.
- B. An outage is defined as prohibiting or restricting a plumbing, electrical or operational service from routine operation (see attached outage request for service included). For purposes of repair, replacement or connection to an existing system, this standard shall be followed.

- C. All persons requesting an outage shall complete an "Outage Request Form" included at the end of this Section.
- D. Contractor shall submit, in writing with the "Outage Request Form", a plan on the work to be performed during the outage, including length of time and reason the utility system must be shutdown. Contractor, in conjunction with the COR, shall research and identify all systems affected by Outage as well as locating and listing all components by tag or facility equipment number, and all the action required at each to achieve the outage. Submit written Plan and Outage Form 14 days in advance of requested outage to COR.
- E. All "Outage Request Forms" and the Outage Plan shall be forwarded to the "Plant Operations and Maintenance Manager" for review and approval prior to scheduling. Contractor shall attend weekly Outage Review Meetings and be prepared to answer questions and discuss the plan.
- F. After approval by the Plant Operations and Maintenance Manager, the outage shall be scheduled by wither the Buildings or Utilities Superintendent (according to the services requested for outage). Government's representative will notify the Contractor, in writing, to proceed. No outage shall proceed prior to written notification form the Government's Representative.
- G. All "Outage Request Forms" and the Outage Plan shall be reviewed by the construction foreman or superintendent for feasibility and necessity.
- H. All systems, when shutdown, shall be tagged in accordance with OSHA and GPO lock-out tag-out procedures.
- I. The number and duration of all outages shall be minimized.
- J. A master outage list, with the approximate required dates, shall be submitted to the COR within 14 days from the commencement of work.

Attachments: Outage Request Form

END OF SECTION 22 05 00

OUTAGE REQUEST FORM

DATE: _____

OUTAGE REQUESTED BY: _____

DEPARTMENT/COMPANY NAME: _____

PURPOSE OF OUTAGE: _____

DATE NEEDED: _____

BUILDING AFFECTED: _____

AREA WITHIN BUILDING TO BE AFFECTED: _____

THE FOLLOWING SERVICES ARE REQUESTED TO BE REMOVED FROM SERVICE:

_____ HOURS

- | | | |
|----|---------------------------|-----------------------------------|
| a. | ___ FIRE PROTECTION | ___ SPRINKLER |
| | | ___ HOSE CABINET/STANDPIPE SYSTEM |
| b. | ___ COLD WATER (DOMESTIC) | |
| c. | ___ SANITARY SEWER | |
| d. | ___ HOT WATER (DOMESTIC) | |
| e. | ___ STEAM | |
| f. | ___ CHILLED WATER | |
| g. | ___ HEATING WATER | |
| h. | ___ AIR HANDLING SYSTEMS | |
| i. | ___ ELEVATOR | |

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

- 22 05 00-20

SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Identification labels, warning signs, stencils, and nameplates for piping and equipment; valve tags; and wire markers.
- B. Identification and labeling requirements for control panels, instrumentation, including control valves and dampers, control instruments, panel instruments, wire, cable and tubing, shall be per specification sections 25 00 00 50, "Identification".

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 22 05 00 - Basic Plumbing Materials and Methods
- C. Section 22 11 23 - Plumbing System Pumps
- D. Section 22 20 00 - Plumbing Services Piping
- E. Section 22 34 00 - Domestic Water Heaters

1.3 QUALITY ASSURANCE

- A. All work, materials, equipment, installation and accessories shall comply with the International Plumbing Code and all District and federal regulations.
- B. Comply with requirements of the following:
 - 1. ASME A13.1, Scheme for the Identification of Piping Systems.
 - 2. ANSI Z535.1, American National Standard for Safety Colors.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, accessories, supports, fittings, finishes, construction details, and dimensions of assemblies and components:
 - 1. Labels
 - 2. Warning Signs
 - 3. Nameplates
 - 4. Valve Tags

5. Wire Markers

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced and shall be the latest adopted date of the publication. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials and perform all labor required for a complete identification system as indicated on the drawings and as specified.

PART 2 PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Metal Nameplates for Equipment:

1. Material and Thickness: Brass, 0.032-inch; stainless steel, 0.025-inch; aluminum, 0.032-inch; or anodized aluminum, 0.032-inch; minimum thickness metal plates, with predrilled or stamped holes for attachment hardware.
2. Minimum Nameplate Size: Length and width vary for required nameplate content, but not less than 2-1/2-by-3/4-inch.
3. Minimum Letter Size: 1/2-inch-high block type, with capital white letters on a black background for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering:
 - a. Provide 1/2-inch-high white letters on a red background for emergency operating instructions for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Plastic Nameplates for Equipment:

1. Material and Thickness: Multilayer, laminated, multicolor, phenolic plates with beveled edges for mechanical engraving, 1/8 inch, with predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures of up to 160 degrees F.
3. Minimum Nameplate Size: Length and width vary for required nameplate content, but not less than 2-1/2-by-3/4-inch.
4. Minimum Letter Size: Engraved 1/2-inch-high block type, with capital white letters on a black background for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering:
 - a. Provide engraved 1/2-inch-high white letters on red background for emergency operating instructions for viewing distances of up to 72 inches, and proportionately

larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

- C. Fasteners: Stainless steel rivets or self-tapping screws.
- D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- E. Nameplate Content: Include equipment's Drawing designation or unique equipment number.
- F. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, with predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures of up to 160 degrees F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.
- D. Minimum Letter Size: 1/2-inch for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- E. Fasteners: Stainless steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- H. Label Content: Include caution and warning information plus emergency notification instructions.
- I. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Seton.

2.3 PIPE LABELS

- A. Preprinted, color coded pipe labels, with lettering indicating service and showing flow direction in accordance with ASME A13.1 and ANSI Z535.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service. Also include:

1. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
2. Lettering Size: Size letters in accordance with ASME A13.1 for piping, however; not less than 1-inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

E. Manufacturer: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.4 VALVE TAGS

- A. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers filled with black paint:
1. Tag Material: Solid, Polished Brass, 0.04-inch minimum thickness or Aluminum, 0.031-inch minimum thickness, as applicable, with predrilled or stamped holes for attachment hardware.
 2. Tag Size: 1-1/2-inch diameter.
 3. Fasteners: Brass S-hook or Aluminum S-hook, as applicable.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses:
1. Include valve-tag schedule in operation and maintenance data.
- C. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.5 WARNING TAGS

- A. Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing:
1. Size: Approximately 4-by-7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
- B. Manufacturers: Brady, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.6 WIRE MARKERS

Requirements shall be per Specification 25 00 00 "Chiller Plant Control System". See paragraph 2.4 Wire, Cable, and Tube Identification. "

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.
- E. Protect finished identification to ensure that markings are clear and legible when project is turned over to the Government.

3.3 INSTALLATION OF EQUIPMENT NAMEPLATES, WARNING SIGNS, AND WARNING LABELS

- A. Permanently fasten nameplates, signs, and labels on each item of plumbing equipment.
- B. Warning Sign and Label Colors:
 - 1. White letters on an ANSI Z535.1 safety-green background.
- C. Locate equipment labels where accessible and visible.
- D. Equipment requiring identification:
 - 1. Expansion Tanks
 - 2. Flow Meters
 - 3. Domestic Water Heaters
 - 4. Pumps
 - 5. Tempering Valves
 - 6. Water Mixing Valves
 - 7. Water Softeners
- E. Electrical Items: Identify disconnect switches, starting devices, controls, control switches, pushbutton stations with nameplates.
- F. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. On each type of service.
 2. Mains and principal branches of piping.
 3. Within 3 feet of each valve and control device.
 4. Near each branch connection, excluding short take-offs.
 5. At access doors and similar access points that permit view of concealed piping.
 6. Within 3 feet of equipment items and other points of origination and termination.
 7. Spaced at maximum intervals of 25 feet along each run with a minimum of one marking per room. Reduce intervals to 10 feet in areas of congested piping, and equipment.
 8. At each side of penetration of walls, partitions and floors within one foot of penetration.
- C. Do not apply pipe labels or tapes directly to bare pipes conveying fluids at temperatures of 125 degrees F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Wrap the circumference of pipe, overlapping both ends of each marker to give 360-degree identification.
- E. Flow Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Pipe-Label Color Schedule:

PIPING SERVICE	TEXT/BACKGROUND COLOR
___ Deg. F Hot Water	White/Green (Note 1)
___ Deg. F Hot Water Recirculation	White/Green (Note 1)
Cold Water	White/Green (Note 1)
Compressed Air (government installed)	White/Blue (Note 1)
Condensate Drain	White/Green
Domestic Hot Water	White/Green (Note 1)
Electric Traced	Black/Orange
Sanitary Vent	White/Black
Sanitary Waste	White/Black
Storm Water	White/Black
Tempered Water	Black/Yellow

Note 1: Provide Safety color for background to comply with ANSI Z535.1.

3.5 INSTALLATION OF VALVE, REGULATOR, AND CONTROL TAGS

- A. Install tags on valves and regulators, except check valves, valves within factory-fabricated equipment units, shutoff valves, and similar roughing-in connections of end-use equipment and units:
 - 1. Valves adjacent to equipment they serve need not be tagged.
- B. Valve-Tag Application: Tag valves according to size, shape, and service.
- C. Charts, Diagrams:
 - 1. Provide charts or diagrams of size and type as approved to enable quick identification, designating number, service or function, and location of each valve:
 - a. Include normal operating position (open, closed, or modulating).
 - 2. Include outline plan of building indicating location and number of each riser, with its control valve.
 - 3. Frame charts and diagrams in approved wood or metal frames with clear glass front, secure to walls in location as directed.
 - 4. Bind one copy of this information in the Operating and Maintenance Manual.

3.6 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where applicable.

3.7 WIRE MARKERS

- A. Identify control wires with wire markers.

END OF SECTION 22 05 53

SECTION 22 07 00 - PLUMBING INSULATION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Insulation for piping and equipment specified in Division 22.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 07 84 13 - Penetration Firestopping
- C. Section 22 05 00 - Basic Plumbing Materials and Methods
- D. Section 22 11 23 – Plumbing System Pumps
- E. Section 22 20 00 – Building Plumbing Services Piping

1.3 QUALITY ASSURANCE

- A. Unless otherwise noted, pipe insulation shall have a K value insulation conductivity Btu inch/hour-ft² degrees F in accordance with IECC 2018.
- B. Insulation on pipes through floors, fire rated walls, and smoke barriers shall be UL listed fire-stop insulation to maintain fire resistance of the floor, fire rated wall, or smoke barrier in accordance with NFPA 101.
- C. Field applied canvas, woven glass fiber reinforcing mesh, woven polyester mesh, and woven glass fiber cloth coverings shall be flame and mildew proof.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods."
- B. Each type of insulation: Manufacturer and product designation, surface burning characteristics, thickness, density in pounds in accordance with cubic foot (kilograms in accordance with cubic meter), thermal conductivity or R-value, water-vapor permeance thickness, jackets (factory and field applied), and accessories.
- C. System application for each type of insulation.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application of pipe expansion joints for each type of insulation.

1.5 INFORMATIONAL SUBMITTALS

- A. Statement of compliance with IECC 2018.
- B. Statement of compliance with NFPA 90A, flame spread index, and smoke developed index requirements.
- C. Statement of compliance with National Architectural and Industrial Maintenance Rule for VOC levels on Adhesives, Mastics, and Coatings for the District of Columbia.
- D. Statement of compliance with Ozone Transport Commission for VOC levels on Adhesives, Mastics, and Coatings for the District of Columbia.

1.6 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Where insulation must be stored outdoors, provide polyethylene film cover for protection. Insulation that becomes wet shall be replaced; drying of insulation is not acceptable.
- B. Coordinate sizes and locations of supports, hangers and insulation shields specified in other sections of the specifications.
- C. Coordinate clearance requirements for installation of insulation and field-applied jackets, finishes for pipe and equipment installation, and space for maintenance.
- D. Coordinate with installation and testing of heat tracing.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products shall comply with the National Architectural and Industrial Maintenance (AIM) Rule for VOC levels for the District of Columbia.
- C. Products shall comply with the Ozone Transport Commission limits for VOC levels for the District of Columbia.

- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable to ASTM C795.

2.2 ADHESIVES, MASTICS, COATINGS

A. Adhesives:

1. Type A1:

- a. High tack, rapid setting water-based adhesive.
- b. Solvent free, low VOC (0.03 pounds/gallon) synthetic elastomer emulsion.
- c. Non-flammable when wet and fire-resistive when dry.
- d. Moisture resistant.
- e. Flame spread index 0 and smoke developed index 0.
- f. Asbestos, lead, and mercury free.
- g. ASTM C916 Type II.

B. Mastics:

1. Type M1:

- a. White, flexible, water-based vapor barrier mastic.
- b. Low VOC (0.3 pounds/gallon).
- c. Non-flammable when wet and fire-resistive when dry.
- d. Water resistant and low water vapor permeance.
- e. Flame spread index 5 and smoke developed index 25.
- f. Asbestos, lead, and mercury free.
- g. MIL-C-19565C, Type II.

C. Coatings:

1. Type C1:

- a. White, washable, abrasion-resistant coating.
- b. Low VOC (0.13 pounds/gallon).
- c. Fire resistant.
- d. Flame spread index 10 and smoke developed index 5.
- e. Asbestos, lead, and mercury free.
- f. MIL-A-3316C, Class I, Grade A.

D. Manufacturers: Childers, Foster, Mon-Eco Industries.

2.3 INSULATION TYPES

A. Type A:

1. Insulation: Pre-formed, sectional molded glass fiber pipe insulation bonded with a thermosetting resin meeting ASTM C547 Standard Specifications for Mineral Fiber Pipe Insulation, Type I, Grade A.
 2. Minimum Density: 3.0 pounds per cubic foot.
 3. Factory Applied Jacket: White, polypropylene-coated ASJ jacket with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
 4. Factory-fabricated shapes in accordance with ASTM C450 and ASTM C585.
 5. Insulated Fitting Covers: Insulation insert with PVC cover equivalent to Zeston.
 6. Operating Temperatures: 0 to 850 degrees F.
 7. Maximum Moisture Vapor Transmission: 0.01 perms.
 8. Manufacturers: Johns-Manville Micro-Lok HP Ultra, Knauf Earthwool 1000o Pipe Insulation, Owens-Corning Fiberglass Insulation SSLII with ASJ Max.
- B. Type C:
1. Insulation: Flexible, closed-cell elastomeric pipe insulation equal to AP Armaflex SS or AP Armaflex Ultra (for air plenums), meeting ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Type I.
 2. Minimum Density: 3.0 to 5.0 pounds cubic foot.
 3. Material shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as tested by ASTM E84.
 4. Insulation Materials shall be listed and labeled per UL723 in plenum spaces, as required by code.
 5. Operating Temperatures: Minus 70 to 220 degrees F.
 6. Maximum Moisture Vapor Transmission: 0.08 perms.
 7. Manufacturers: Aerocell, Armacell, K-flex.
- C. Type D:
1. Insulation: Flexible, unfaced glass fiber blanket bonded with a thermosetting resin meeting ASTM C665 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing, Type I.
 2. Minimum Density: 3/4 pound per cubic foot.
 3. Maximum Operating Temperature: 450 degrees F.
 4. Manufacturers: Johns-Manville Formaldehyde-Free Fiberglass Insulation, Knauf EcoRoll Insulation, Owens-Corning RA Series EcoTouch.
- D. Type F:
1. Insulation: Semi-rigid, glass fiberboard bonded with a thermosetting resin meeting ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks, Type II or IIIA, Category 2.
 2. Minimum Density: 2.5 pounds per cubic foot:
 - a. Up to and Including 22-inch Diameter: Sectional molded type.
 - b. Twenty-four-inch Diameter and Above: Sectional molded type or rigid board accurately beveled or scored.
 3. Factory Applied Jacket: White, polypropylene coated ASJ jacket, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
 4. Operating Temperatures: 35 to 850 degrees F.
 5. Maximum Moisture Vapor Transmission: 0.02 perms.

6. Manufacturers: Certain-Teed CrimpWrap Pipe & Tank, Johns-Manville Micro-Flex, Knauf KwikFlex, Owens-Corning Flex Wrap ASJ.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136:
 1. Width: 3 inches.
 2. Thickness: 10.8 mils.
 3. Adhesion: 45 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
 7. Manufacturers: Ideal Tape Co., Johns-Manville, Knauf, Owens-Corning, 3M, Venture Tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136:
 1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 45 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
 7. Manufacturers: Ideal Tape Co., Knauf, Owens-Corning, 3M, Venture Tape.

2.5 FIELD APPLIED PIPE JACKETS

- A. PVC Jacket:
 1. High-impact resistant, UV-resistant PVC complying with ASTM D 1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) compounds and Chlorinated Polyvinyl Chloride (CPVC) compounds. and Class 16354-C; 30 mils thick, roll stock ready for shop or field cutting and forming.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White Color-coded jackets based on system.
 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 5. Manufacturers: Johns Manville; P.I.C. Plastics, Inc.; Proto Corporation; Speedline Corporation.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications:
 1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.

6. Manufacturers: ABI, Compac Corporation, Venture Tape.
- C. PVC Jacket Adhesive: Compatible with PVC jacket:
 1. For indoor applications; adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Manufacturers: Dow Corning Corporation 739, Dow Silicone; Johns Manville Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive; P.I.C. Plastics, Inc. Welding Adhesive; Speedline Corporation Polyco VP Adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application:
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation of loose scale, dirt, oil, water, and other foreign materials that will adversely affect insulation application.
- B. Complete piping and equipment tests before insulation is applied.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Do not apply insulation until heat tracing has been tested. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water. If insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL PREPARATION AND APPLICATION REQUIREMENTS

- A. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system, as specified in insulation system schedules.
- B. Insulate completely metal surfaces of piping other than hangers as delineated under Extent of Insulation.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

- D. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- E. Install insulation with least number of joints practical.
- F. Permit expansion and contraction without causing damage to insulation or surface finish.
- G. Extend surface finish to protect surfaces, ends, and raw edges of insulation.
- H. Fire-stop insulation shall be continuous to 6 inches on either side of barrier. Seal jacket seam and end joints to adjacent sections of insulation for continuous vapor barrier. Annular space between insulation and sleeve shall be sealed as specified in Section 22 05 00, "Basic Plumbing Materials and Methods," in the Article titled, "Sleeves and Escutcheon Plates.":
- I. Provide vapor retarding barriers continuous and uninterrupted throughout the system where specified.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with water-based vapor-barrier mastic:
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with water-based vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Where connections are made to existing systems, provide insulation as specified and to match existing where existing insulation is removed or damaged for new connection. Provide vapor barrier continuously sealed to the existing insulation.
- L. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- M. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- N. Install multiple layers of insulation with longitudinal and end seams staggered.
- O. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- P. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that become wet.
- Q. Cut insulation in a manner to avoid compressing insulation.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- T. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 2. Cover circumferential joints with 3-inch wide strips of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c:
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
- U. Coordinate insulation installation with installation of heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.4 PENETRATIONS

- A. Roof and Aboveground Exterior Wall Penetrations: Install insulation continuously through penetrations:
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface for roof penetrations, and at inside wall surface for wall penetrations. Seal with joint sealant.
 - 3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 4. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing for roof penetrations, and outside wall flashing for wall penetrations and overlap wall flashing at least 2 inches.
 - 5. Seal jacket to roof flashing and wall flashing with flashing sealant.
- B. Non-Fire Rated Interior Floor, Wall and Partition Penetrations: Install insulation continuously through floors, walls and partitions.
- C. Fire-Rated Floor, Wall and Partition Penetrations:
 - 1. Pipe: Install insulation continuously through floor, wall, and partition penetrations.
 - 2. Seal penetrations through fire-rated assemblies according to Section 07 84 13, "Penetration Firestopping."
- D. Vermin Proofing: Wherever insulated piping pass through sleeves or openings which are required to be vermin proof, provide sections of foamed glass insulation equal in length to length of sleeves. Refer to Section 22 05 00, "Basic Plumbing Materials and Methods," in the Article titled, "Sleeves and Escutcheon Plates" for details and extent of vermin proofing.

3.5 GENERAL INSULATION INSTALLATION

A. Piping:

1. Insulate valves, strainers, fittings, unions, mechanical couplings, flanges, and other specialties.
2. Install insulation with continuous thermal and vapor retardant integrity, unless otherwise noted.
3. Use preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe where available. Where preformed material is not available, use sectional pipe insulation.
4. Insulate pipe elbows and butt tightly against adjoining piece and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
5. Insulate tee fittings and butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
6. Insulate valve bodies and flanges up to and including bonnets, valve stuffing-box studs, bolts, and nuts. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement.
7. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Provide a removable, reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
8. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels:
 - a. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
9. Where specified, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
10. Fill hollow interior of protection saddles with insulating cement.
11. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
12. Where removable insulation covers are indicated, make insulation form sectional pipe insulation of the same thickness as that of the adjoining pipe. Install same insulation jacket as that of the adjoining pipe insulation.

3.6 ADHESIVES, MASTICS, COATINGS

- #### A.
- Apply adhesives, mastics and coatings at the rate of coverage and in a manner recommended by the manufacturer.

- B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise noted.
- C. Mastics shall comply with MIL-C-19565C, Type II.
- D. Lagging adhesives shall comply with MIL-A-3316C, Class I, Grade A.

3.7 INSULATION TYPES

A. Type A:

1. Application:

- a. Pipe: Fit insulation to pipe, staggering longitudinal joints. Seal longitudinal joint overlaps with 4-inch-wide sealing strips of vapor barrier jacket material applied on circumferential joints with Type A1 adhesive. Seal end joints and protrusions with Type A1 adhesive. Seal with a 1/16-inch-thick coat of Type M1 mastic for cold lines. Seal with a 1/16-inch-thick coat of Type C1 coating for hot lines. Imbed a layer of glass fiber fitting tape in the mastic or coating and after the initial coat has dried, apply an additional 1/16-inch coat of mastic or coating.
- b. Flanges, Fittings, Elbows, Valves, and Pipe Specialties: Apply fabricated or premolded insulated fitting covers or insulating cement equal in thickness and density to adjoining pipe insulation. Seal with a 1/16-inch-thick coat of Type M1 mastic for cold lines. Seal with a 1/16-inch-thick coat of Type C1 coating for hot lines. Imbed a layer of glass fiber fitting tape in the mastic or coating and after the initial coat has dried, apply an additional 1/16-inch coat of mastic or coating:
 - 1) Fill voids with mineral fiber blanket insulation.
 - 2) Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing insulation.

2. Surface Finish:

a. All piping.

1) Pipe:

- a) Standard duty, concealed and exposed – no additional finish required.
- b) Heavy Duty - Apply a tack coat of Type C1 coating over entire surface; imbed a layer of 8-ounce canvas; when dry, apply a second coat of Type C1 coating.

2) Fittings and Valves:

- a) Standard Duty – no additional finish required.
- b) Heavy Duty – Apply a finish coat of Type C1 coating after mastic has thoroughly dried.

3) Apply heavy-duty surface finish to pipes, fittings, and valves in the following locations: Mechanical Equipment Rooms and exposed areas.

b. For piping outdoors:

Apply 0.016-inch aluminum metal jacket with vapor barrier. Place preformed 2-inch butt strap with sealant over seams and secure with 1/2-inch aluminum band and wing seal. Factory-Fabricated Fitting Covers:

- a) Same material, finish, and thickness as jacket.
- b) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- c) Tee covers.
- d) Flange and union covers.
- e) End caps.
- f) Beveled collars.
- g) Valve covers.
- h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

B. Type C:

- 1. Pipe: Slip the insulation over the pipe wherever possible or slit the insulation sections and apply around the pipe. Seal seams and end joints with ArmaFlex 520 adhesive or equivalent to prevent the passage of air to the surface being insulated.
- 2. Flanges, Fittings, Elbows, Valves and Pipe Specialties: Fabricate segments of insulation, miter joints using preformed pipe insulation, and sections of pipe insulation in accordance with manufacturer's instructions or use prefabricated fittings from the manufacturer or recommended third party. Seal with insulation manufacturer's adhesive to prevent the passage of air to the surface being insulated.
 - a. Fill voids with cut sections of insulation same thickness as pipe insulation.
 - b. Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing insulation.
- 3. Outdoors:
 - a. Apply two coats of WB Armaflex finish, or approved equal, in accordance with manufacturer's instructions and recommendations.
 - b. Locate seams on lower half of the pipe.

C. Type D:

- 1. Wrap two or more layers as required for thickness specified firmly around pipe bundle.
- 2. Secure with cord tied on 9-inch centers.
- 3. Cover insulation with 45 pound per cubic foot roofing felt secured with bands or wire. Option: 0.016-inch aluminum jacket for piping not in trenches.

D. Type F:

- 1. Apply to pipe bundle, staggering longitudinal joints to provide a complete and tight fit to the contour of the pipe bundle on the exterior.
- 2. Seal longitudinal joint jacket overlaps and 4-inch wide sealing strips of jacket material applied on circumferential joints with Type A1 adhesive or self-sealing laps.
- 3. Use stainless steel staples to assist in securing scored board insulation where joint is hidden.

3.8 FIELD APPLIED PIPE JACKETS

- A. Install PVC jackets on exposed insulated piping. Provide with 1-inch overlap at longitudinal seams and end joints for horizontal applications. Seal with manufacturer's recommended adhesive:
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Install metal jackets on outdoor insulated piping. Provide with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.9 INSTALLATION SCHEDULE

- A. Piping:

PIPING SYSTEM	MATERIAL TYPE	INSULATION THICKNESS IN INCHES FOR PIPE SIZE				
		Less than 1"	1 to less than 1-1/2"	1-1/2 to less than 4"	4 to less than 8"	8" & Larger
Electric Heat Traced Piping (Note 6)	A	1	1	1	1	1-1/2
Electric Heat Traced Piping (insulated as a bundle)						
Bundle diameter less than 10-inch	D	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4
Bundle diameter 10-inch and larger	F	1	1-1/2	1-1/2	2	2-1/2
Control Air 25 ft. Downstream of Refrigerated Air Dryer	C	1/2	1/2	1/2	1/2	1/2
Indoor Domestic Cold Water (except trap primers and in Mechanical Equipment Rooms)	A, C (Note 1)	1/2	1/2	1	1	1
Domestic Cold Water (in Mechanical Equipment Rooms and Outdoors)	A, C (Note 1)	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2

PIPING SYSTEM	MATERIAL TYPE	INSULATION THICKNESS IN INCHES FOR PIPE SIZE				
		Less than 1"	1 to less than 1-1/2"	1-1/2 to less than 4"	4 to less than 8"	8" & Larger
Outdoor and Indoor Domestic Hot or Recirculating Water 140°F or less	A	1	1	1-1/2	1-1/2	1-1/2
	C	1	1	1-1/2	1-1/2	1-1/2
	(Note 1)					
Indoor Non-Potable Cold Water (except in Mechanical Equipment Rooms)	A, C (Note 1)	1/2	1/2	1	1	1
Non-Potable Cold Water (in Mechanical Equipment Rooms and Outdoors)	A, C (Note 1)	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
Horizontal Portions of Rain and Overflow Conductors; Bottom of Roof and Overflow Drain Bodies; and Riser to Roof Drains and Overflow Pipes	A, C (Note 1)	1	1	1	1	1
Indirect Refrigerator Waste	A, C (Note 1)	1	1	1	1	1
Air Conditioning Condensate and Refrigerator Waste	A	1/2	1/2	1	1	1
	C (Note 1)	3/4	3/4	1	1	1
Branch Waste or Storm Drain Carrying Air Conditioning Condensate or Refrigerator Waste	A, C (Note 1)	1	1	1	1	1

Note 1: Type C may be used in lieu of Type A, where indicated, at Contractor's option, for pipes up through 2-inch except where heavy-duty finish is required.

3.10 EXTENT OF INSULATION

- A. Piping: Insulate as designated in Installation Schedule.

END OF SECTION 22 07 00

SECTION 22 11 29 - PLUMBING SYSTEM PUMPS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Pumps and accessories, supports, component piping, and controls associated with plumbing system piping.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 22 05 00 – Basic Plumbing Materials and Methods
- C. Section 22 05 53 – Identification for Plumbing Piping and Equipment
- D. Section 22 07 00 - Plumbing Insulation
- E. Section 22 20 00 – Plumbing Piping
- F. Section 22 34 00 - Domestic Water Heaters
- G. Section 22 40 00 - Plumbing Fixtures and Equipment
- H. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. All work, materials, equipment, installation, and accessories shall comply with the International Plumbing Code and all District and federal regulations.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, appurtenances, accessories, supports, fittings, finishes, construction details, and dimensions of assemblies and components:
 - 1. Domestic Hot Water Recirculating Pump
- C. Certification for pumps for NSF 61 compliance.
- D. Operating and Maintenance Data.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials, equipment and perform all labor required for complete plumbing pumping systems as indicated on the drawings and as specified
- B. The domestic hot water recirculation pump shall be mounted in mixing valve assembly unit specified in other sections of the specifications.

1.7 WARRANTY

Manufacturers standard warranty.

PART 2 PRODUCTS

2.1 TYPE J - DOMESTIC HOT WATER RECIRCULATING PUMP

- A. Drawing Designation: 04 03 PL PMP-1.
- B. Pump shall be non-overloading throughout the range of the curve.
- C. Capacity shall be as scheduled on drawings.
- D. Lead-free, in-line Bell & Gossett PL series close-coupled circulator, stainless steel shaft, cupro-nickel shaft sleeve, mechanical seal, oil lubricated sleeve bearings.
- E. Manufacturers: Armstrong, Bell & Gossett, Taco, Thrush.

2.2 TYPE P - CONDENSATE SUMP PUMP

- A. Drawing Designation: 04 00 PL PMP-1, 04 02 PL PMP-1, AND 04 03 PL PMP-2
- B. Provide Little Giant Pump Company Model VCM-15ULS or approved equal.
- C. Unit shall be a vertical type-pumping unit, with high impact polystyrene tank, ABS motor, tank covers, volute and impeller.
- D. Duty: As scheduled on the drawings.
- E. Float switch.
- F. Thermally protected motor and stainless steel shaft.

- G. Equip with snap action switch, 6-foot long cord with 120 volt plug and safety switch.
- H. Provide a check valve with 3/8-inch outside diameter discharge.
- I. Manufacturers: Hartell, Liberty, Little Giant.

PART 3 EXECUTION

3.1 TYPE J - DOMESTIC HOT WATER RECIRCULATING PUMP

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Provide automatic control to cycle pump on at 122 degrees F and off at 125 degrees F.

3.2 TYPE P - CONDENSATE SUMP PUMP

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Install shutoff valve and silent check valve in discharge pipe.
- C. Secure plug to outlet in lockable enclosure.

END OF SECTION 22 11 29

SECTION 22 20 00 - BUILDING PLUMBING SERVICES PIPING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Piping, fittings, joints, valves, strainers, supports, anchors, expansion joints, guides, and flow measurement systems for Division 22.
- B. Instrumentation requirements associated with controls, not limited to temperature transmitters, gauge pressure transmitters, differential pressure transmitters, continuous level transmitters, electrically actuated valves, electric valve actuators, shall be per specification sections 25 00 00 70 and 25 00 10 70, "Instrumentation".

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 22 05 00 – Basic Plumbing Materials and Methods
- C. Section 22 07 00 – Plumbing Insulation
- D. Section 22 11 23 – Domestic Water Pumps
- E. Section 22 34 00 - Domestic Water Heater
- F. Section 22 40 00 - Plumbing Fixtures and Equipment
- G. Section 23 05 93 - Testing, Adjusting, and Balancing
- H. Section 23 65 13 - Packaged Cooling Towers

1.3 QUALITY ASSURANCE

- A. Valves shall conform to ASME Boiler and Pressure Vessel Code Specifications where indicated or required by state or local code.
- B. All inline devices installed on the domestic service lines or building distribution system downstream of the water main and before end point devices and is in contact with the water intended for human ingestion shall comply with the Safe Drinking Water Act and National Sanitary Foundation (NSF) Standard 61 and Standard 372 to provide lead-free water (not containing more than 0.25 percent lead):
 - 1. Inline devices include water meters, valves, check valves, strainers, meter stops, backflow preventers, fittings, etc.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods".
- B. Statement of piping and fitting material, and type of joint to be used for each piping system.
- C. Manufacturer's technical product data, installation instructions, and description of accessories for each type to be used and system designation:
 - 1. Valves
 - 2. Strainers
 - 3. Pipe Supports
 - 4. Insulation Protection
 - 5. Expansion Joints including Compressive Force
 - 6. Flow Measurement Systems
 - 7. Thermometers and Test Wells
 - 8. Pressure Gages and Test Connections
- D. NSF 61 Certification of domestic water devices.
- E. Anchor guide details, locations, and methods of securing to building.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Workmanship:
 - 1. Cut pipes accurately to measurements established at structure.
 - 2. Install without springing or forcing.
 - 3. Clear windows, doors, and other openings.
 - 4. Permit expansion and contraction without misalignment or damage.
 - 5. During construction, close openings in piping and equipment to keep out foreign matter and to prevent leakage.
 - 6. Piping shall be concealed unless otherwise indicated.
 - 7. Provide offsets required to avoid structural or other interference without extra cost to the Government.
- B. Drainage:
 - 1. Grade to low points.
 - 2. Provide hose end drain valves at bottom of risers, low points, and where indicated.
- C. Access: All valves, unions, flanges, expansion joints, and flow measurement devices shall be installed in accessible locations.

PART 2 PRODUCTS

2.1 FITTINGS AND ACCESSORIES

- A. Reducers: Reducing fittings, eccentric type where required to prevent pocketing of air and water.
- B. Unions, Flanges, Mechanical Couplings, and Gaskets:
 - 1. Suitable for intended duty and rated for not less than system test pressure.
 - 2. Dielectric (insulating) type in water piping systems, suitable for intended service.

2.2 PIPE, FITTINGS AND JOINTS

- A. Pipe:

TYPE	REFERENCE
A	Cast Iron Soil Hub and Spigot Pipe and Fittings: Service weight, except where extra heavy is specified, ASTM A74, 10-foot lengths where possible. Pipe and fittings shall be marked with the collective trademark of the CISPI and NSF listed or receive prior approval from the Contracting Officer's Representative.
E	Black Steel Pipe: American Steel only in compliance with ASME B31.9; ASTM A53 Grade B, ERW or seamless; or ASTM A106 Grade B seamless. Sizes through 10 inches, standard weight, 12 inches and larger 3/8-inch wall.
G	Cast Iron Hubless (No-Hub) Pipe and Fittings: Cast Iron Soil Pipe Institute Standard (CISPI) No. 301 and ASTM A888. Install and support in accordance with Cast Iron Soil Pipe Institute recommendation. Pipe and fittings shall be marked with the collective trademark of the CISPI and NSF listed or receive prior approval from the Contracting Officer's Representative.
K	Seamless Copper Water Tube: ASTM B88, Type "K" soft temper.
L	Seamless Copper Water Tube: ASTM B88, Type "L" hard temper; ASTM B280 for Type ACR.
A1	Polypropylene Pipe and Fittings: Schedule 80 pipe manufactured from virgin unpigmented pipe grade polypropylene; pressure rated for 80 psi at 40 degrees C.
A2	Sanitech Sani-Pro T Polypropylene: Manufactured from virgin unpigmented polypropylene.
A3	Tubing 316L ASTM A-269 Stainless Steel Seamless. 3/4" OD 316L shall have 0.065" wall and 3,300 psi working pressure. 1/2" OD 316L shall have to 0.049" wall and 3,700 psi working pressure

- B. Fittings:

TYPE	REFERENCE
BB	Wrought Copper Solder Joint Fittings: ANSI/ASME B16.22.
DD	Black Malleable Iron Screwed Fittings: 150 psi ANSI/ASME B16.3.
LL	Cast Iron Screwed Drainage Fittings: ANSI/ASME B16.12.
WW	Stainless steel Swagelok tube fittings and joints.
VV	Sanitech Sani-Pro T polypropylene joints with unitized heat formed sanitary ferruled ends, manufactured from virgin unpigmented polypropylene.

C. Joints:

TYPE	REFERENCE
1	Threaded-American Standard for Pipe Threads: ANSI B1.20.
2	Mechanical locked end screw design.
3	Packed Oaken or Hemp: ASTM B29, filled molten lead driven to final setting in accordance with National Standard and International Plumbing Codes.
7	Soldered: ASTM B32; Tin-antimony, 95-5, tin silver 96-4, or tin silver 94-6.
9	Brazed-Silver Alloy Brazing equal to Sil-Fos and Easy-Flow by Handy and Harman.
10	Gasket-Neoprene Double Seal Compression Type: ASTM C564 for hub and spigot cast iron pipe couplings.
12	Heat-Fused: In accordance with manufacturer's recommendations.
16	Mechanical Couplings for Hubless (No-Hub) Cast Iron Pipe: CISPI-310 with ANSI Type 301-305 stainless steel clamps and shield, ASTM C-564 with integral custom pipe stop. Couplings in aboveground piping shall conform to the requirements of CISPI 310 and ASTM C1277 and shall be heavy-duty Type 304 stainless steel shield, bands, and tightening devices with 3/8-inch socket, and ASTM C564 rubber sleeve with integral, center pipe stop, equal to Husky SD, Series 4000 or Clamp-All Hi-Torq 125. Couplings shall bear the NSF trademark.
22	Sanitech Sani-Pro T polypropylene sanitary ferruled joints with true union clamps. Silicon gaskets.

2.3 VALVES

- A. Manufacturer's Tests: Each valve shall be given shell and seat tests by the manufacturer and shall carry a permanently affixed indication that tests have been successfully completed.
- B. ASME Boiler Code Compliance: Provide valves, that conform to ASME Boiler Code Specifications, where indicated, or where required by state or local code.
- C. Combination Balancing and Shutoff Valve:
 - 1. Domestic Cold and Hot Water Systems:
 - a. Type C:
 - 1) Calibrated ball valve type equal to Bell & Gossett Circuit Setter Plus:
 - a) NSF 61 Listed lead-free valve.
 - b) Pressure/temperature ports with check valves.
 - c) Positive shutoff
 - d) Memory setting feature.
 - e) Calibrated nameplate.
 - f) Sizes: 1/2 to 1-inch.
 - g) Manufacturers: Bell & Gossett or approved equal.
- D. Valves used on domestic water lines shall be NSF 61 Listed.

- E. Drain Valves: Hose end ball valve with cap and chain equal to NIBCO Fig. T-585-70-HC ball with American Standard Garden Hose type threads. Drain valves on potable water systems shall include a vacuum breaker hose connection.
- F. Gate, Globe, and Check Valves:
1. Gate and globe valves designed for repacking under pressure when fully opened, and equipped with packing suitable for the intended service. When the valve is fully opened, the back seat shall protect the packing and the stem threads from the fluid. Each gate and globe valve shall have a gland follower.
 2. Bronze valves with the basic saturated steam rating of 125 psi or 150 psi shall have pressure containing parts of a material having at least the physical properties of ASTM Specification B-62. Metallic seated bronze globe, angle, check and gate valves with a basic steam rating of 200 or 300 psi having pressure containing parts of material conforming to ASTM B-61, for temperatures to 550 degrees F.
 3. Pressure containing parts of iron body valves shall be of material conforming to ASTM A-126 Grade B. If the wedge in OS&Y gate valves is fastened to the stem by threads, it shall be secured by a nickel alloy or monel pin.
 4. Face-to-face and end-to-end dimensions of iron body valves to conform to ASME B16.1. Design, workmanship, materials, and testing to conform to MSS-SP-70, MSS-SP-71, and MSS-SP-85 (Manufacturers Standardization Society of the Valve and Fitting Industry).
 5. Solid wedge type gate valves, designed and manufactured in such a way that seating surfaces are prevented from contacting until near the point of closure.
 6. Handwheels of ASTM A47 malleable iron or ASTM A126, Class A or B iron.
 7. Manufacturers: Unless otherwise indicated, Crane, Grinnell, Hammond, Kennedy, Milwaukee, NIBCO, Powell or Stockham equal to NIBCO or other listed manufacturer figure numbers as noted in Schedule of Services paragraph below.
- G. Ball Valves:
1. Ball valves shall have stem extension to place handle outside the insulation when valve is to be installed in insulated piping.
 2. Type A: Bronze or brass body, /bronze or brass /stainless steel/ ball and stem, reinforced Teflon seats and seals, full port size, threaded or solder end as required scheduled through 2-inch size and acceptable for 2-1/2-inch size if valve is full port. Valve shall be three-piece or shall have removable cartridge to permit complete access removal, and replacement of components without removal of the valve from the piping system and without disturbing the piping system. NIBCO 595-Y.
 3. Type C: Stainless steel body, ball and stem, reinforced teflon seats and seals, reduced port, flanged end. NIBCO F510-S6-R-66.
 4. Type D: Lead-free silicon brass alloy body, stem, and ball, Virgin PTFE seats, EPDM seals, full port size, threaded or soldered end as /required /scheduled/ through 2-inch size and acceptable for 2-1/2-inch size if valve is full port. Valve shall be two-piece and be NSF 61 listed. NIBCO 685-80-LF.
 5. Manufacturers: Unless otherwise indicated, Apollo, Contromatic, Crane, Dynaquip, Fairbanks, Hammond, ITT Grinnell, Jamesbury, MarPac, /Milwaukee/, NIBCO, Powell, Watts, Webstone, Worcester for the types listed in Schedule of Services paragraph below.
- H. Schedule of Services: Unless otherwise indicated, valves are for aboveground service. Size range indicated is size of pipe where valves are required. Valves shall be pipe size or larger. Unless otherwise indicated FIGURE NO. indicates NIBCO number.

DOMESTIC HOT AND COLD WATER				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Ball	2-1/2-4-inch	Min. Size Valve 3-inch; NSF 61 Compliant	-	Type C
Ball	2-1/2-inch Option	Full Port; NSF 61 Listed	-	Type D
Ball	2-inch and Smaller	NSF 61 Listed	-	Type D
Check	3-inch and Smaller	NSF 61 Listed	Screwed End Soldered End	TI-413-Y-LF SI-413-Y-LF

PUMP DISCHARGE				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Ball	2-inch and Smaller	-	-	Type A
Globe	2-inch and Smaller	-	Screwed End Soldered End	T-235-Y S-235-Y
Check	2-inch and Smaller	-	Screwed End Soldered End	T-433-B S-433-B

REVERSE OSMOSIS WATER				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Ball	-	-	-	George Fisher 346
Shutoff in Recirculated Main	-	Unpigmented Polypropylene Body; Teflon Diaphragm	Diaphragm Valve; Sanitary Connection or Union and Threaded Connection	Sani-Tech
Shutoff in Dead Legs to Outlets or Equipment	-	Unpigmented Polypropylene Body; Teflon Seals; Viton Seals	True-union Ball Valve	-
Check	-	Unpigmented Polypropylene Body and Ball; Viton Seals	Ball-type Check Valve; Sanitary Connection or Union and Threaded Connection	-

FOGGING WATER (REVERSE OSMOSIS FOR HUMIDIFICATION)				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Ball	-	All stainless steel	-	Swagelok GB Series

2.4 STRAINERS

- A. Size and Screen Openings: Provide full line size strainers irrespective of equipment connection size. Provide free area of screen not less than 2-1/2 times inlet pipe area.
- B. "Y" Type: For 2-inch and smaller Mueller No. 11 with open bottom stainless-steel screen. For 2-1/2-inch or larger, Mueller No. 758 with open bottom stainless-steel screen.
- C. Perforations: Diameter of perforations, water service 4-inch and smaller - 0.057-inch.
- D. Drain: Pipe plug or factory-installed hose-end drain valve as indicated on drawings.
- E. Interior lining shall comply with FDA-approved, epoxy coating or NSF 61 compliant on domestic water lines.
- F. Manufacturers: Boylston, McAlear, Mueller, Spence, Tate Andale, Sarco, Nicholson, Metraflex, Keckley.

2.5 PIPE SUPPORTS

- A. General: Supports shall be plastic coated for plastic pipe, copper plated for copper tubing and brass pipe, galvanized for uninsulated galvanized steel pipe, and black steel for other metallic piping. Outdoor supports shall be copper plated for copper tubing and brass piping, and galvanized for all other piping.
- B. Horizontal Piping:
 1. Clevis Hangers: Adjustable wrought steel clevis hangers.
 2. Under Supports:
 - a. Where no provision for expansion and contraction is required:
 - 1) Floor Mounted: Adjustable cast iron saddle with floor flanges secured to floor and pipe nipple of suitable length.
 - 2) Trapeze or Metal Frame Mounted: Inverted U bolts with saddle supports for insulated pipe.
 - 3) Wall Mounted: Steel J hooks for pipes 3-inch and smaller; welded steel brackets for larger pipes with hanger or support same as for trapeze.
 - b. Where provision for expansion and contraction is required provide adjustable pipe roller and base secured to support. For floor mounting provide concrete pier under base; for wall mounting provide welded steel bracket.
 3. Metal Frame Supports:

- a. Provide as required, vertical and horizontal 12 gage galvanized steel channels and fittings bolted together to form a multiple pipe rack secured to the building structure with post bases and brackets. Equal to Grinnell Power-Struct, ASTM A-446, Grade A, hot dipped zinc coated steel with safety end enclosures.
 - b. Manufacturers: B-Line, Steel City, Unistrut, Grinnell.
 4. Lateral Movement: Provide dual movement type rollers where under supports are required and where expansion and contraction will cause lateral movement.
- C. Vertical Piping:
1. Steel extension pipe clamps for piping not subject to vertical movement by expansion or contraction.
 2. Variable spring supports for piping subject to vertical movement by expansion or contraction.
 3. Base fitting set on concrete, brick pier or pipe stand where necessary at bottom of piping risers.
- D. Insulation Protection:
1. Saddle: 18 gage galvanized sheet metal.
 2. Roller Saddle: Curved steel with protecting lugs or turned up edges.
 3. Thermal Shield: 360 degree insert of waterproofed calcium silicate insulation with 100 psi compressive strength encased in galvanized steel jacket equivalent to Pipe Shields, Inc. Model A1000 (CS). Use Model A3000 (CSX) wherever pipe hanger span exceeds 10 feet and for pipe roller applications. Insert shall be same thickness as adjoining pipe insulation. Shield length and minimum sheet metal gages as indicated. Where pipe hanger spacing exceeds 10 feet and where pipe rollers are used, provide double layer shield on bearing surface.
 4. Manufacturers: B-Line, Pipe Shields, Inc., Value Engineered Products.

PIPE SIZE IN INCHES	SHIELD LENGTH IN INCHES	MINIMUM GAGE
½ – 1-1/2	4	26
2 – 6	6	20
8 – 10	9	16

2.6 PIPE PEDESTALS

- A. Furnish pipe mounting pedestals equal to Roof Products and System Corp., Model ER-4A, where indicated on the drawings. The pipe mounting pedestal shall include equipment rail, sized for the number of pipes and specified in this section, as associated galvanized steel slide channel attached to “U” shaped mounting brackets and secured to side of equipment rails with lag bolts supplied. The pipe roller assembly shall have galvanized 18-inch-long continuous threaded rod to give 12-inch vertical adjustment, galvanized removable pipe retainer bracket for 12-inch horizontal adjustment. All pipe mounting pedestals shall be factory assembled.
- B. Manufacturers: Caddy Pyramid, Pate, Roof Products and Systems Corporation.

2.7 PIPE PORTALS

- A. Furnish pipe portals equal to Roof Products and Systems Corporation, where indicated on the drawings. The pipe portal shall include an 18-gage galvanized steel roof curb, Model RC-4A, with integral baseplate, continuously welded corner seams, factory-installed wood nailer and 1-1/2-inch, 3-pound density rigid fiberglass insulation.
- B. The pipe portal shall be provided with a laminated acrylic-coated ABS plastic curb cover with prepunched holes and molded sealing ring on an 8-inch collared opening, and an EPDM compression molded cap with stainless steel snaplock clamps.
- C. Curb covers shall be resistant to ozone and ultraviolet rays and shall have a serviceable temperature range of minus 40 to 350 degrees F. The protective rubber caps shall have a serviceable temperature range of minus 60 to 250 degrees F and shall be resistant to ozone and ultraviolet rays. The conical shaped steps of the nipple shall provide a weatherproof seal around the penetration. The stainless steel snaplock clamps shall provide added protection to guarantee the seal.
- D. Manufacturers: Pate, Roof Products and Systems Corporation.

2.8 PIPE ANCHORS

- A. Unless otherwise indicated, provide anchors consisting of steel collars, clamps or similar devices welded to pipe and structural framing of building.

2.9 PRE-FABRICATED FLEXIBLE HOSE EXPANSION LOOP

- 1. Equivalent to Metraflex Metraloop or V-loop.
- 2. Manufacturer shall be responsible for sizing the flexible hose expansion joint and provide anchor and guide locations.
- 3. Provide manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
- 4. Flexible-hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder joint end connections:
 - a. Two-inch and smaller: Bronze hoses and single braid bronze sheaths with 450 psig at 70-degree F and 340 psig at 450-degree F ratings.
 - b. 2-1/2 to 4 inches: Stainless-steel hoses and single braid, stainless-steel sheaths with 300 psig to 70-degree F and 225 psig at 450-degree F ratings.
- 5. Manufacturers: Flex-Hose Co., Inc., Flexicraft Industries, Flex-Pression, Ltd., Metraflex, Inc.

2.10 PIPE GUIDES

- A. Provide guide with a cast steel or cast-iron segmented spider secured to the pipe and free to move axially in a segmented steel cylinder anchored to structure. Guide size shall be large enough to permit pipe insulation to be continuous and of uniform thickness.

2.11 FLOW MEASUREMENT SYSTEMS

Flow Meters shall be per specification sections 25 00 00 70, "Instrumentation".

2.12 THERMOMETERS AND TEST WELLS

A. Types:

1. Direct Mounting: 5-inch dial, externally calibrated, standard industrial bimetal, with stainless steel stems and cases equal to Weston Models 4503 and 4513. Stem length - minimum, 1/2 depth of pipe; maximum, 24 inches.
2. Where indicating points cannot be conveniently read or temperature correctly sensed, provide organic fluid filled protected capillary tube for remote mounting.

B. Ranges:

1. For Media Temperatures not Exceeding 100 degrees F: 25 to 125 degrees F).
2. For Media Temperatures above 100 degrees F, but not Exceeding 220 degrees F: 30 to 240 degrees F.

C. Accessories: Provide with separable brass wells with insulation extension on insulated pipe.

D. Manufacturers: Ashcroft, Marsh, Marshalltown, Moeller, Taylor, Tel-Tru, Trerice, U.S. Gage, Weiss, Weksler, Weston, Winters.

E. Test Wells: Thermowells shall be per specification sections 25 00 00 70, "Thermowells"

2.13 PRESSURE GAGES AND TEST CONNECTIONS

A. Type: General purpose bronze bourdon tube, bronze bushed movement mounted on socket independent of case, 1 percent minimum accuracy at mid-range, 4-1/2-inch white face equal to Ashcroft Catalog No. P2070A.

B. Ranges: Approximately twice the maximum operating pressure. Provide compound gages wherever negative pressures can occur.

C. Accessories: Provide gages with Trerice No. 735 or 740 valve suitable for intended pressure, temperature and service and, for steam, brass siphon tubes. For pump and compressor suction and discharge, provide porous core snubbers.

D. Manufacturers: Ashcroft, Marsh, Marshalltown, Moeller, Taylor, Tel-Tru, Trerice, U.S. Gage, Weiss, Weksler, Weston, Winters.

E. Test Connections: Provide with Trerice No. 735 or 740 gage valves suitable for intended pressure.

PART 3 EXECUTION

3.1 FITTINGS AND ACCESSORIES

A. Reducers: Use reducing fittings to make changes in pipe sizes.

B. Unions, Flanges, Mechanical Couplings, and Gaskets:

1. Install at each piece of equipment, in bypasses, and long piping runs to permit disassembly for alteration and repairs.
2. Equipment Connections: Provide piping connections which conform to indicated sizes, details, reviewed shop drawings, and printed installation instructions furnished by manufacturer.
3. Dielectric (Insulating) Type: Install in water piping systems where pipes of dissimilar metals are joined and where unions are required by contract documents.

C. Threads: Remove burrs and ream to full inside diameter.

3.2 PIPE, FITTINGS AND JOINTS

A. Schedule:

SYSTEM	PIPE	FITTINGS	JOINTS
Sanitary Drainage and Vent			
1. Aboveground: Within building, 10-inch and smaller - See Note 1	G	G	16
Storm Drainage			
1. Aboveground: Within building, 10-inch and smaller - See Note 1	A G	A G	3, 10 16
2. Pumped Discharge: 2-inch and smaller	L	BB	7
Domestic Cold Water			
1. Aboveground: 2-1/2-inch and larger	L	BB	9
2. Aboveground: 2-inch and smaller	L	BB	9
Trap Primer	K	BB	7
Domestic Hot Water, Tempered Water			
1. Aboveground	L	BB	9
Domestic Water Heater Relief, Water Heater Safety Pan Drain	L	BB	7
Air Conditioning Condensate, Air Conditioning Condensate Pumped Discharge			
1. Aboveground: 2-1/2-inch and larger * Extra Strong Pipe	E*	LL	1
2. Aboveground: 2-inch and smaller	L	BB	9
Compressed Air for Systems	E	DD	1
Reverse Osmosis Water	A1 A2	WW	12 22
Fogging Water (Reverse Osmosis for Humidification)	A3	WW	2

NOTES:

- (1) Type A and G not permitted for sump and sewage ejector pump discharge piping.

3.3 VALVES

- A. Adjust for smooth and easy operation.

- B. Install in locations where valve can easily be adjusted.
- C. Install valves full size of pipe before reducing size to make connection to equipment and controls.
- D. Remove excess solder and other foreign matter from valve interior after installation before operating valve.
- E. Provide chainwheel operators for valves in equipment rooms mounted greater than 7 feet above floor level. Extend chain to 7 feet 0 inches above floor level.
- F. Cut Off or Stop Service: Gate or ball, as specified.
- G. Throttling or Control Valve Bypass: Globe.
- H. Balancing Valves:
 - 1. Three-inch and Smaller: Combination balancing and shutoff valve.
- I. Preset Balancing valve to be preset to indicated pressure drop.
- J. Set field adjustable flow set point of balancing valves.

3.4 STRAINERS

- A. Support strainers at pumps independent of piping system.

3.5 PIPE SUPPORTS

- A. Preparation and Application:
 - 1. Provide supports to maintain required slope and alignment.
 - 2. Secure hangers to rods with double nuts.
 - 3. Make allowance for expansion and contraction.
 - 4. Do not support pipes from ducts or other pipes.
 - 5. Use trapeze hangers for parallel runs of pipe with same slope.
 - 6. Provide bracing to prevent lateral motion of horizontal or vertical piping.
 - 7. Provide supports at or near changes in direction.
 - 8. Do not pierce ducts with hanger rods.
 - 9. Provide strength and rigidity suitable for loads imposed.
 - 10. Support piping so there is no strain on the connection to pumps and other equipment.
 - 11. Support piping using mechanical couplings in accordance with manufacturer's instructions and recommendations.
- B. Horizontal Piping:
 - 1. Adjustment: Provide vertical adjustment of supports for horizontal piping after installation.
 - 2. Maximum Support Spacing:
 - a. Steel Lines: 1-1/2-inch and smaller, 6 feet; 2-inch and larger, 10 feet.
 - b. Copper Lines: 1-1/2-inch and smaller, 5 feet; 2-inch and larger, 8 feet.

- c. Cast Iron Soil Pipe: One support at each joint, but not greater than 10 feet.
 - d. Polypropylene: 2-inch and smaller, 2 feet; larger than 2 inches, 3 feet continuous support.
 - 3. Metal Frame Supports: Space frames in accordance with smallest pipe requirements and design for a maximum deflection of 1/360 of the span.
- C. Vertical Piping:
 - 1. Support vertical lines at locations indicated. Where not indicated, support plastic, copper, and cast-iron soil pipe at every floor, steel pipe at every other floor. Brace plastic piping on maximum 6-foot centers.
 - 2. Where supports are necessary at bottom of risers, provide a base fitting set on either concrete or brick pier or a pipe stand. In lieu of using a base fitting, a hanger at bottom horizontal connection may be used. Locate hanger as close to riser as possible, but permitting sufficient free offset where allowance for expansion and contraction is necessary.
- D. Insulation Protection:
 - 1. Provide saddle for piping 4-inch and smaller. Provide thermal shield for piping larger than 4-inch. Thermal shields for pipes 4-inch and smaller is optional.
 - a. Saddle: Provide hangers outside of covering. Between hanger and covering, provide sheet metal saddle formed to fit bottom half of the insulation. Minimum side dimension of saddle equal to 1/2 the insulation circumference.
 - b. Thermal Shield: Provide 3-inch-wide vapor barrier tape or band over butt joints. Where vapor barrier is required, apply a wet coat of vapor barrier lap cement on butt joints before applying tape or band. Coordinate with Section 22 07 00, "Plumbing Insulation."
 - 2. Roller Saddle: Provide where insulated piping lines are supported on rollers. Weld lugs to pipe.

3.6 PIPE PEDESTALS

- A. Install in accordance with manufacturer's instructions and recommendations.

3.7 PIPE PORTALS

- A. Install in accordance with manufacturer's instructions and recommendations.

3.8 PRE-FABRICATED FLEXIBLE HOSE EXPANSION LOOP

- A. Install in accordance with manufacturer's recommendations.

3.9 PIPE GUIDES

- A. Wherever expansion loops or expansion joints are installed, provide concentric type pipe alignment guides.
- B. Locate and install guides in accordance with the standards of the Expansion Joint Manufacturer's Association and compensator manufacturer's recommendations.
- C. Pipe supports shall not be considered a guide.
- D. Provide guides where required to permit line movement without buckling and misalignment.
- E. Secure guides directly to structural framing of floors or roof or to their supporting members.
- F. Obtain COR's review of guide details, location and method of securing to building before proceeding with installation of guides.

3.10 FLOW MEASUREMENT SYSTEMS

- A. Locate measuring device in accessible locations with straight section of pipe upstream and downstream as recommended by the manufacturer for good accuracy.
- B. Locate horizontally mounted measuring device pressure taps on side of pipe.

3.11 THERMOMETERS AND TEST WELLS

- A. Install thermometers at temperature control points and elsewhere as indicated.
- B. Install test wells where indicated on the drawings, located above horizontal position in pipe with 12-inch minimum clearance above well.

3.12 PRESSURE GAGES AND TEST CONNECTIONS

- A. Install pressure gages at pressure control points elsewhere as indicated.
- B. Install test connections suitable for intended pressure in piping where indicated for testing.

3.13 PIPE TESTING

- A. Preparation and Application:
 - 1. Test piping to prove tightness.
 - 2. Test concealed piping before enclosing.
 - 3. Replace and re-test pipe or fittings broken or damaged under test.
 - 4. Remove or protect from damage items not designed to withstand testing pressure; e.g., control devices, air vents.
 - 5. Advise COR prior to tests.
- B. Standing Water Test:

1. Plug and test sanitary, vent, and storm water piping with water by filling to the top of highest pipe.
2. Test sections of piping separately with a minimum head of 10 feet of water.
3. Test drainage piping above food storage, preparation and serving areas with a minimum head of 25 feet of water.
4. Piping shall show no leakage after standing for eight hours.

C. Pressure Testing:

1. Test pressures shall be 1-1/2 times the system working pressures and a minimum of 100-psi, unless otherwise indicated.
2. Test water piping hydrostatically protecting traps, seals, etc. from excess pressure.
3. Valves shall be open, but not backseated for packing check. However, it is permissible to test against a closed valve if the test pressure does not exceed the valve pressure rating at test temperature.
4. Blind flanges, or the equivalent, shall be used instead of valves for dead-end shutoff.
5. Inspect each joint for leakage while under test.
6. Apply soapsuds to joints under air pressure test.
7. Maintain pressure tests for a minimum of four hours.
8. Maintain applicable safety methods while performing tests. These methods shall include but shall not be limited to applying pressure at increments of 25 psi, providing sufficient time to allow the piping to equalize strains, until specified test pressure is attained. The piping system shall be examined only when the pressure in it is not increasing.
9. Test reverse osmosis water with RO water.
10. Test reverse osmosis water piping hydrostatically to 2,500 psi.
11. Perform fire protection piping tests in compliance with NFPA 13.

END OF SECTION 22 20 00

SECTION 22 34 00 - DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Domestic service, potable water heating equipment, accessories, controls, component piping and supports. Includes electric water heaters and expansion tanks.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 22 05 00 - Basic Plumbing Materials and Methods
- C. Section 22 05 53 – Identification for Plumbing piping and Equipment
- D. Section 22 07 00 - Plumbing Insulation
- E. Section 22 11 23 – Plumbing System Pumps
- F. Section 22 20 00 – Building Plumbing Services Piping
- G. Section 22 40 00 – Plumbing Fixtures and Equipment
- H. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. All work, materials, equipment, installation and accessories shall comply with the International Plumbing Code, District of Columbia Energy Conservation Code, and all District and federal regulations.
- B. Comply with requirements of the following:
 - 1. ASME Boiler and Pressure Vessel Code
 - 2. UL Standards
 - 3. ASHRAE Standard 90.1-2013, Energy Standard for Buildings except Low Rise Residential Buildings, Section 7.
- C. Tank insulation shall comply with ASHRAE 90.1-2013 and District of Columbia Energy Conservation Code.
- D. Water heaters and storage tanks shall have a temperature and pressure relief valve with ASME and AGA (CGA) ratings and label. Valves shall also be in accordance with ANSI 221.22. Relief valves shall be automatic reseating type with test lever. Relief valves shall have extension thermostat element with a non-metallic protective coating to retard mineral deposits.

- E. Tank and potable waterside surfaces shall be suitable for potable water and acceptable by FDA for potable water.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, accessories, supports, fittings, finishes, construction details, and dimensions of assemblies and components:

Electric Water Heaters
Expansion Tank

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced and shall be the latest adopted date of the publication. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials, equipment and perform all labor required for a complete domestic water heating system as indicated on the drawings and as specified.
- B. Heating capacity and size as indicated on drawings.

1.7 WARRANTY

- A. Electric Water Heater shall have 10-year warranty.

PART 2 PRODUCTS

2.1 TYPE E - ELECTRIC WATER HEATER

- A. Drawing Designation: 04 03 PL DWH-1.
- B. Provide Bradford White electric water heater or equivalent.
- C. Duty: Heater capacity and tank size as indicated on the drawings.
- D. Unit shall be prewired with immersion thermostats, manual reset limit switch, low-water cutoff, temperature and pressure relief valve, and safety door interlock.
- E. Construct in accordance with ASME Code Section HLW for 125 psig working pressure.

- F. Unit shall comply with all UL safety specifications.
- G. The steel tank shall be lined on waterside with a nonporous, thermosetting, hydrophobic and elastomeric coating or a glass lining (Vitrage). Tank shall have a full 5-year warranty.
- H. Non-ferrous tank connections.
- I. Equip at factory with the following:
 - 1. Steel support skids and lifting lugs.
 - 2. Console mounted thermometer and pressure gages.
 - 3. High and low immersion thermostats.
 - 4. Immersion high temperature limiting control.
 - 5. Temperature and pressure relief valve.
 - 6. Low water cutoff.
 - 7. Steel jacketed, fiberglass insulation.
 - 8. Baked enamel finish, steel jacket.
 - 9. ASME stamp for test and working pressure.
 - 10. 80 W/In2-density elements incoloy sheathed individual 18 kW elements.
 - 11. Control circuit transformer, control circuit switch, fuse and pilot light.
 - 12. Four-step proportional sequencer.
 - 13. Tank drain valve.
 - 14. Tank manway access.
- J. Manufacturers: A.O. Smith, Bradford-White, Cemline, Patterson Kelly, PVI Industries, Inc.

2.2 SAFETY DRAIN PAN

- A. Provide a galvanized steel metal drain pan for installation under Electric Water Heaters.
- B. Pan shall extend 1-inch beyond edge of water heater and shall be not less than 1-1/2 inches deep and shall have a minimum 3/4-inch chain connection.

2.3 EXPANSION TANK

- A. Drawing Designation: 04 03 PL EXT-1.
- B. Construction:
 - 1. Bell & Gossett Model PT-60V or approved equal, ASME labeled, steel pressure rated tank, constructed with welded joints and factory installed FDA approved, butyl-rubber diaphragm.
 - 2. NSF listed: Standard 61.
 - 3. Tapings: Factory fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - 4. Interior Finish: Comply with NSF 61 and 372 barrier materials for potable water tank linings, including extending finish into and through tank fittings and outlets.
 - 5. Air Charging Valve: Factory installed. Include air precharge to minimum system operating pressure at tank.
 - 6. Working Pressure: 150 psig.

- C. Duty: Capacity and size as indicated on drawings.
- D. Manufacturers: Amtrol, A.O. Smith, Armstrong, Bell & Gossett, State, Taco, Watts, Wessels, Wilkins.

PART 3 EXECUTION

3.1 WATER HEATER

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Manufacturer's representative shall supervise start of unit; check unit operation, controls and safety devices; and instruct Owner's personnel in proper operation and maintenance.
- C. Pipe relief valve discharge full size to nearest floor drain.
- D. Electric power shall be connected to control panel under the Electrical Division.
- E. Field wiring shall meet requirements of Electrical Division.

3.2 SAFETY DRAIN PAN

- A. Install metal drain pan under Type H water heater.
- B. Pipe 3/4-inch drain to plumbing fixture, receptor, floor drain, or disposal point.

3.3 EXPANSION TANK

- A. Install in accordance with manufacturer's instructions and recommendations.

END OF SECTION 22 34 00

SECTION 22 40 00 - PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Plumbing fixtures and specialties; fittings; supports; as indicated on the drawings, as required by code and as specified.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 06 41 00 - Architectural Wood Casework
- C. Section 10 28 00 - Toilet Room Accessories
- D. Section 21 13 00 - Fire Suppression
- E. Section 22 05 00 - Basic Plumbing Materials and Methods
- F. Section 22 07 00 - Plumbing Insulation
- G. Section 22 20 00 – Building Plumbing Services Piping
- H. Section 22 34 00 – Domestic Water Heaters
- I. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. All work, materials, equipment, installation and accessories shall comply with the current enforced edition of the International Plumbing Code, DC DCMR 12F DC Plumbing Code Amendments, and all District and federal regulations.
- B. Comply with requirements of ADA and ANSI Standards and District of Columbia Accessibility Code for plumbing fixtures and fittings for wheelchair accessibility.
- C. All inline devices installed on the domestic service lines or building distribution system downstream of the water main and before end point devices and is in contact with the water intended for human ingestion shall comply with the Safe Drinking Water Act and National Sanitation Foundation (NSF) Standard 61 and Standard 372 to provide lead free water (not containing more than 0.25 percent lead):
 - 1. Inline devices include water meters, building valves, check valves, meter stops, fittings, backflow preventers, etc.

- D. Provide UL label on electric powered equipment or certification that the equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 22 05 00, "Basic Plumbing Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, appurtenances, accessories, supports, fittings, finishes, construction details, and dimensions of components:
 - 1. Plumbing Fixtures and Accessories
 - 2. Automatic Trap Primers
 - 3. Trap Primers
 - 4. Drains
 - 5. Cleanouts
 - 6. Shock Absorbers
 - 7. Vacuum Breakers
 - 8. Backflow Preventers
 - 9. Hose Bibbs
 - 10. Water Mixing Valves
- C. NSF 61 Certification of domestic water devices.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials, equipment and perform all labor required to install plumbing system complete as indicated on the drawings and as specified.
- B. Plumbing system includes fixtures, equipment, piping and the supports for these items; supplies; stops; faucets; spouts; showerheads; traps; drains; tailpieces; fittings and accessories.
- C. Provide all plumbing fixtures and equipment with accessible stops.
- D. Provide P-traps on fixtures for which traps have not been included as part of the furnished equipment. Size of trap shall be equal to size of fixture tailpiece.
- E. All exposed metal parts of fixtures shall be chromium-plated brass. Piping, fittings, valves, traps and accessories, including piping escutcheons, shall be chromium plated metals where exposed in finished spaces.

1.7 WARRANTY

- A. Manufacturers standard warranty.

PART 2 PRODUCTS

2.1 PLUMBING FIXTURES AND SUPPORTS

- A. Provide fixtures as listed. Catalog numbers are American Standard, unless otherwise noted.
- B. Fixtures shall be vitreous china unless otherwise noted. Cast iron fixtures shall have acid resisting enamel finish.
- C. Flush valves shall be self-closing, non-hold open type with vacuum breaker and perform satisfactorily when subjected to inlet water pressure varying from 20 to 75 psi. Flush valves shall comply with ADA and not require a force greater than 5 lbf to operate.
- D. Restricting Flow Fittings and Flow Restricting Aerators:
 - 1. Provide restricting flow fittings or flow restricting aerators on self-closing type lavatory faucets to restrict flow to 0.5 gpm.
 - 2. Provide restricting flow fittings or flow restricting aerators on non-self-closing and non-metering sink faucets to restrict flow to 2.2 gpm.
 - 3. Restrictor shall compensate for pressure fluctuations between 25 to 80 psig with flow within 10 percent.
 - 4. Manufacturers: Dole, Omni Products
- E. Plumbing Fixture Schedule:
 - 1. P101 - Water Closets:
 - a. Water Closet: 2257.001 "Afwall," siphon jet action, 1.6 gallons flush, elongated bowl, wall hung, 1-1/2-inch top spud. Fitted with:
 - 1) Electronic Flush Valve: Sloan Royal No. 111 ESS-1.6, hard wired flush valve with 1-inch Bak-Chek screwdriver angle stop with cap, flush connection, infrared sensor, and coupling for 1-1/2-inch top spud, wall and spud flanges/
 - 2) Seat: Church No. 9500SSC, white, extended back seat for elongated bowl, open front, no cover, stainless steel check hinge.
 - b. Mounting Height: Seat to floor – 17 inches. Mounting Height: Seat to floor - 17 inches.
 - 2. P-201 – Urinals:
 - a. Urinal: 6561.017 "Trimbrook," siphon jet urinal, 1.0-gallon flush, extended side shields, 3/4-inch top spud, approximately 13.5 inches from wall to front lip, wall hangers, 2-inch threaded outlet connection. Fitted with:
 - 1) Electronic Flush Valve: Sloan Royal No. 186 ESS-1.0 valve, 3/4-inch Bak-Chek screwdriver angle stop with cap, flush connection, hard wired, infrared sensor range adjustment screw, courtesy flush override button and coupling for 3/4-inch top spud, wall and spud flanges.

- b. Mounting Height: Floor to rim – 17 inches.
- 3. P-301 – Lavatories:
 - a. Lavatory: 0356.421 "Lucerne," 20 by 18-inch vitreous china lavatory, single hole centers. Fitted with:
 - 1) Electronic Faucet: Chicago EQ-C11A-13ABCP series deck mounted chromeplated electronic faucet, AC power, with concealed thermostatic mixing valve and with coverplate.
 - 2) Trap: McGuire No. 8902 1-1/4 by 1-1/2-inch adjustable P-trap, cast body, cleanout plug, slip inlet tubing drain to wall, cast brass escutcheon and set screw.
 - 3) Support: Provide concealed arms.
 - 4) Waste, Tailpiece: McGuire 155WC chromeplated wheelchair lavatory, cast grid drain plug with strainer and offset 1-1/4-inch tailpiece.
 - 5) Supply Pipes: McGuire 158WC, 3/8-inch wheelchair supply with loose key straight-stop with cast brass escutcheon, and set screw.
 - b. Mounting Height: Provide clear floor space underneath in accordance with ADA Section 305 and knee and toe clearance in accordance with ADA Section 306, but no more than 34 inches from the floor to top of rim.
- 4. P-401 – Sinks:
 - a. Small Countertop Sink: Just SL-1613-A-GR, 16 by 13 inches, undercoated 18 gage stainless steel sink with 3-hole punch, 8-inch centers. Furnish sink with Bridgeport No. 667 chromeplated cup strainer and tailpiece. Fitted with:
 - 1) Faucet: Chicago 786-GR8-EV317AB, chromeplated faucet with 4-inch wrist blade handles, E3 aerator with 2.2 gpm flow restrictor. GR8 restricted rigid swing gooseneck spout.
 - 2) Supply Pipes: Brass Craft SR-1512-A, chromeplated supply, loose key stop valve, cast brass escutcheon and set screw, flexible tube riser.
 - 3) Trap: Kohler K-9000, 1-1/2 by 1-1/4-inch chromeplated P-trap, cast body, cleanout plug, slip inlet tubing drain to wall, cast brass escutcheon and set screw.
- 5. P-504 - Drinking Water Coolers:
 - a. Drinking Water Cooler Bi-level: (ADA)
 - b. Halsey Taylor Model No. LVRCGRNTL8WSK bottle filling station & bi-level unit for both wheelchair accessibility and general public use. Wall-mounted air-cooled electric water cooler that shall deliver 8 GPH of 50 degrees F at 90 degrees F ambient and 80 degrees F inlet water. Water control pushbars shall be located on front of unit. Top shall be stainless steel with removable drain strainer. Cabinet shall be platinum finish. Separate valve and automatic stream regulator shall be mounted within cabinet. Refrigeration system shall have hermetically sealed, positive start compressor with lifetime lubrication and built-in overload protection. Compressor shall operate with HFC-134A refrigerant. Cooler shall comply with ANSI 117.1 and with Americans with Disabilities Act. Provide 27 inches clear knee space underneath, but no more than 30 inches measured from finished floor to spout outlet for wheelchair accessible unit. Unit

shall be AHRI certified in accordance with AHRI Standard 1010-94. The unit shall be certified to be lead-free as defined by Safe Drinking Water Act.

6. P-601 – Showers:

- a. Shower: Aquarius Model S4136BF-FUS left-hand or right-hand, acrylic molded one-piece white wheelchair accessible shower unit with no seams or joints. Shower shall meet ANSI A117.1 and 124.1 with a back side fire rating of "A" and flame spread index of less than 25 and designed to meet ADA, FHA, HUD, IBC, NAHB, UPC requirements, 5-year limited warranty. Inside dimensions shall be 36 by 36 by 81-1/2 inches and weigh approximately 180 pounds and have an integral dome. Fitted with:
 - 1) Valve: Symmons S-9605-PLR-B30-TRM with S-262XBODY valve and 2DIVBODY SRT diverter valve Temptrol, pressure-balancing mixing valve, integral stops, maximum temperature limit stop. Hand shower with 59-inch flexible hose, vacuum breaker, No. 40 chrome street elbow wall connection with flange, chromeplated brass escutcheon, lever handle, 4-458 lever diverter valve with integral volume control. Chrome bar, 30 inches long, with adjustable slide and hood for hand shower. Mount vacuum breaker above bar.
 - 2) Showerhead: Symmons No. 4-226F Clear-Flo showerhead with 2.0 gpm flow regulator, spray adjusting handle and No. 300 chromeplated shower arm with cast brass chrome flange.
 - 3) Drain: Aquarius, 2-inch brass drain, with stainless steel strainer. Provide P-trap.
 - 4) Grab Bar: Shall conform to ANSI A117.1 and include one 18 by 1/2-inch diameter vertical, and one 17-1/2 by 32-1/2 by 1-1/2-inch diameter 18 gage wrap around horizontal.
 - 5) Accessories: Stainless steel 1-inch diameter curtain rod /and curtain/; molded soap-accessory tray for seated and standing position, phenolic slotted fold-up seat, and 3/4-inch reduced threshold for on slab mounting so there is no pit or burring to meet ADA.
- b. Additional reinforcement shall be suitably located to provide required structural integrity. After all valves, grab bars, curtain rods, and wall brackets, etc., have been installed, they shall be sealed to make the unit waterproof.

7. P-810 - Emergency Fixtures:

- a. Emergency Shower and Eye/Face Wash: Speakman Model SE-607 free-standing emergency shower and aerated eye/face wash with 8-inch /ABS plastic "safety" yellow showerhead, 1-inch chrome-plated brass stay-open valve, "safety" yellow pull rod. Provide emergency sign. Provide a flow switch to operate a remote alarm.
- b. Stanchion: 1-1/4-inch steel pipe and brass fittings painted "safety" yellow with 9-inch brass floor flange. Flow 20 gpm at 30 psi.
- c. Eye/Face Wash: SE-400 integrally-mounted aerated eye/face wash with stainless steel bowl, in-line strainers, chromeplated brass dual spray heads, chromeplated brass stay-open valve activated by stainless steel push handle and foot pedal. Waterways shielded by yellow polypropylene covers. Minimum flow 8 gpm at 30 psi.

F. Plumbing Fixture Supports (Numbers are Josam unless otherwise noted):

1. Wall Hung Water Closet Supports:

- a. Josam 12000 series carrier with flush valve pipe support, vent and appropriate adjustable fitting as required for installation, wheelchair accessible requirements and pipe specified.
 - b. Single or double system as required.
 - c. Double systems shall be designed to prevent crossover of effluent from one bowl to the other.
 - d. Provide closed cell neoprene gasket for sealing water closet to the carrier coupling.
 - e. Carrier shall have auxiliary anchor foot support.
2. Wall-mounted urinal supports, Josam 17560 plate type with cast iron headers, structural steel uprights and welded feet with bearing plate.
3. Support for wall-mounted urinals, lavatories, drinking water coolers, etc.:
 - a. Where fixtures are supported from concrete or cinder block walls, install No. 10 USSG Steel plate on the opposite side of the wall and bolt hangers or supports through plate. Where opposite side of wall is exposed to view, place bolts in core of blocks and fill core with cement.
 - b. Concealed arm type lavatory supports, Josam 17100 for single and 17100-BB for double installation, with cast iron headers, structural steel upright and welded feet and header; and chrome plated cast brass threaded escutcheons for slab type lavatories. Provide Josam 17100-67 for wheelchair accessible lavatories.

G. Manufacturers:

1. Fixtures: American Standard, Crane, Eljer, Kohler, Sloan, and where named:
 - a. Stainless Steel Sinks: American Standard, Elkay, Just, Kohler.
 - b. Acrylic Showers: Aqua-Bath, Aquarius, Fiat, Universal Rundle.
2. Faucets and Accessories: American Standard, Chicago Faucet, Crane, Delta, Eljer, Kohler, Moen, Price Pfister, Speakman, Symmons, T&S Brass.
3. Supplies, Traps: American Standard, Brass Craft, Chicago Faucet, Crane, Eljer, Engineered Brass Co., Keeney, Kohler, McGuire.
4. Flush Valves: Delany, Sloan, Zurn.
5. Water Closet Seats: Bemis, Benecke, Church, Comfort, Olsonite.
6. Fixture Supports: Ancon, Josam, J.R. Smith, MIFAB, Wade, Zurn.
7. Drinking Water Coolers: Elkay, Halsey Taylor, Haws, Oasis, Sunroc.
8. Mixing Valves: American Standard, Lawler, Moen, Price Pfister, Powers, Speakman, Symmons.
9. Showerheads: American Standard, Moen, Powers, Price Pfister, Sloan, Speakman, Symmons.
10. Emergency Eyewashes, Eye/Face Washes and Showers: Bradley, Haws, Speakman, Western.

2.2 DRAINS

- A. Provide drains as listed in schedule. Numbers are Josam unless otherwise noted.
- B. Provide nickel bronze strainers on all floor drains in finished floor areas and painted cast iron strainers on all other floor drains, unless otherwise noted.
- C. Provide flashing clamps on all drains puncturing waterproof membrane and roofing.

- D. Provide suitable flashing material and clamping collar for drains which are not set in place when slab is poured.
- E. Traps for floor drains not used as indirect waste receptors shall be the 4 inches deep seal type provided with automatic trap primers or barrier -type floor drain trap seal protection devices conforming to ASSE 1072 as indicated.
- F. Trap Primer:
 - 1. Type B: Josam 88250-90 Primer Valve, one valve per trap, with removable operating parts, integral vacuum breaker, and gasketed access cover. Drawings are not all inclusive.
 - 2. Type C: PPP DY-4-625 automatic trap primer system, copper body distribution. Brass discharge fittings. Install with vacuum breaker. Refer to drawings for location.
 - 3. Manufacturers: Type A – PPP, Inc. or approved equal. Type B – J.R. Smith, MIFAB, PPP, Inc., Sioux Chief Manufacturing Co., Watts.
- G. Provide Josam 26200 cast iron vertical expansion joint in each rain leader that does not have 90-degree offsets downstream of the roof drain. The expansion sleeve shall be Schedule 80 PVC and shall conduct the rain water beyond the packing. Install expansion joints in accessible locations for repacking.
- H. In lieu of joints specified in Section 22 20 00, "Building Plumbing Services Piping," neoprene gaskets may be used if designed for use with the drains and cleanouts employed and if approved by the local plumbing authority.
- I. Provide roof drains without traps.
- J. Schedule of Floor Drains and Accessories
 - 1. FD-1 - Floor Drain:
 - 2. Josam 30000-6A with Type A round strainer, vertically adjustable and reversible clamp collar. Provide with primer tap where required.
 - 3. FD-7 Floor Drain:
 - a. Josam 32300-SD-81 heavy duty grate, double drainage flange, removable slotted deep sediment bucket. Provide with primer tap where required.
 - 4. FD-10 Floor Drain:
 - a. Josam 49720, 12 by 6 inches with internal anti-splash dome strainer, acid-resisting interior, double drainage flange, with 1/2 full /grate/ with 2-1/2-inch center opening and 9 by 3-1/2-inch oval/ funnel.

2.3 CLEANOUTS

- A. Cleanouts shall be full size of pipe up to 6 inches and shall be 6 inches for 8-inch pipe.
- B. In lieu of joints specified in Section 22 20 00, "Building Plumbing Services Piping," neoprene gaskets may be used if designed for use with drains and cleanouts employed and if approved by the local plumbing authority.
- C. Materials and Manufacturers: Acorn, Josam, J.R. Smith, MIFAB, Wade, Watts, Zurn. Josam numbers are indicated:

CONCEALED PIPING	CAST IRON PIPE	STEEL
Unfinished Areas		
Floors	56000	58460A
Walls	58790	58890
Finished Areas – Floors		
Terrazzo	56040-13	56040-13
Composition Tile	56000-12	56000-12
Ceramic Tile	56020	56020
Carpet	56000-14	56000-14
Finished Areas – Walls		
Plaster	58790	58600
Tile	58790	58640*
* With 9 by 9-inch frame		

EXPOSED AND ACCESSIBLE PIPING	CAST IRON PIPE	STEEL
Walk-in Shafts	58900	58540

2.4 SHOCK ABSORBERS

- A. Josam 75000 Shoktrol shock absorbers. Sizes shall be in accordance with PDI Standard WH-201 and ASSE Standard 1010.
- B. Manufacturers: Ancon, Josam, J.R. Smith, MIFAB, Precision Plumbing Products, Sioux Chief, Wade, Watts, Zurn.

2.5 VACUUM BREAKERS AND BACKFLOW PREVENTERS

- A. Vacuum Breakers:
 1. Atmospheric-type, not subject to back pressure, Watts No. 288A; ASSE 1001.
 2. Subject to back pressure, Watts series 9D; ASSE 1012.
 3. For hose threads, Watts series 8A; ASSE 1011.
- B. Reduced pressure zone for connection to domestic water system and elsewhere as indicated, Watts 909 backflow preventer with strainer and valves; ASSE 1013:
 1. Sizes through 3-inch shall have full-port ball valves.
 2. Sizes 4-inch and larger shall have OS&Y rising stem gate valves.
 3. Valves on backflow preventer supplying water to fire protection system shall be UL/FM listed.
 4. Backflow preventer 2-1/2-inch and larger shall have FDA approved epoxy coating and lining for the entire assembly including valves and strainer.
 5. Backflow preventer 2-inch and smaller shall have bronze strainer and valves; internal polymer coating for preventer body. Provide with air gap for drain outlet.

- C. Double check valve type backflow preventer with strainer, OS&Y rising stem UL/FM listed gate valves and bronze body ball valve test cocks, Watts Series 709; ASSE 1015. Entire backflow preventer including strainer and valves shall have FDA approved epoxy coating and lining:

- 1. Manufacturers: Conbraco, Febco, Hersey, MIFAB, Sloan, Watts, Wilkins, Woodford, Zurn.

2.6 HOSE BIBBS

- A. Chicago Faucets 998-RCF hose-end faucet, rough chrome finish.
- B. Manufacturers: American Standard, Chicago Faucet, Crane, T&S Brass.

2.7 WATER MIXING VALVES

- A. Domestic Water Mixing Valve:

- 1. Type B-1:

- a. Drawing Designation: MV-1.
 - b. Unit shall have a nominal capacity of 124 gpm with a maximum pressure drop across the valve of 30 psi.
 - c. Assembly shall be Lawler Model 804, thermostatically controlled mixing valve, bronze body, stainless steel piston and liner, temperature control valve mounted in a pre-piped manifold system/ which includes the hot water recirculation pump (specified under another Division), stainless steel cabinet circuit setting balancing valve, thermometers, ball valves, mounting strut. Valve shall be pressure compensating.
 - d. Assembly shall include vacuum breakers, union end stops, union connected, stainless steel inlet strainer, and checkstops on hot and cold-water inlets.
 - e. Provide dial thermometer, shutoff valve and union on tempered water outlet.
 - f. Assembly shall also include on/off valve, service lug, and interconnecting piping.
 - g. Valve shall provide protection against hot or cold-water supply line failure and thermostat failure.
 - h. Manufacturers: Holby, Lawler, Powers, Symmons.

- 2. Type B-2:

- a. Drawing Designation: MV-3.
 - b. Unit shall be for individual sink Chicago Faucet ECAST Model 131-ABNF.

- B. Emergency Fixture Mixing Valve

- 1. Type C1 - Tempering Valve:

- a. Drawing Designation: MV-2.
 - b. Speakman Model SE-354 or approved equal, with check valves, ball valves, thermometer with vandal-resistant temperature adjustments for cold, hot, and tempered water flows, and cold-water bypass. Bypass shall be sized to allow required

full fixture flow of cold water if hot water is not available or if actuator fails. Designed to comply with ANSI Z358.1. Provide with surface mounted stainless-steel cabinet with lock and keys.

PART 3 EXECUTION

3.1 PLUMBING FIXTURES AND SUPPORTS

- A. Setting heights of lavatories, drinking water coolers, etc. shall be as directed prior to installation.
- B. Install floor-mounted fixtures only after finished floor has been installed.
- C. Seal water closet to the carrier coupling with a closed cell neoprene gasket. Apply adhesive to front and back of gasket.
- D. Provide rubber concussion washers between vitreous china fixtures and supporting brackets.
- E. Protect chromium plated trim from corrosive solutions used to clean tile work.
- F. Provide ASTM C920, Type S white, silicone caulking where fixtures come in contact with walls and floors. Sealant shall be mildew resistant type.
- G. Shower valve temperature limit stops shall be field set to deliver a maximum outlet temperature of 110 degrees F based on inlet water temperatures of 50 degrees F cold water and 120 degrees F hot water. Confirm outlet temperature in field and adjust as required.
- H. Provide insulation protection in accordance with ADA for exposed traps and supplies for all wheelchair accessible lavatories. Insulation shall provide access to supply valves and shall be equal to Handi-Lav-Guard as manufactured by Truebro, Inc.
- I. Manufacturers: Proto, Truebro.
- J. Flush valves shall be mounted not more than 36 inches above the floor for wheelchair accessible water closets and shall be not more than 44 inches above the floor for wheelchair accessible urinal fixtures. Operating lever for water closet shall be mounted on wide side of water closet area.
- K. Showers: Additional reinforcement shall be suitably located to provide required structural integrity. After all valves, grab bars, curtain rods, wall brackets, etc. have been installed, they shall be sealed to make the unit waterproof.
- L. Examine rough-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- M. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- N. Install counter-mounted fixtures in and attach to casework.
- O. Install fixtures level and plumb according to rough-in drawings.
- P. Install stops in locations where they can be easily reached for operation.

- Q. Install toilet seats on water closets.
- R. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- S. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- T. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- U. Install traps on fixture outlets, except fixtures with integral traps and indirect wastes.
- V. Set shower receptors in leveling bed of cement grout. Grout is specified in Section 22 05 00, "Basic Plumbing Materials and Methods".
- W. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- X. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- Y. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
- Z. Install 12-volt AC transformers in electronic operated mechanisms. Coordinate with Electrical Contractor.
- AA. Replace washers and seals of leaking and dripping faucets and stops.
- BB. Install emergency sign for emergency fixture in a location directed by the COR. Install remote alarm where indicated on the drawings. Coordinate with Electrical Contractor.

3.2 DRAINS

- A. Unless otherwise noted, drains are to be installed at the low point of roof, decks, areaways, floors, etc.
- B. Coordinate floor drain installation to avoid interference with toilet room compartment partitions supported from floor.
- C. Install floor drains in low points, so the top of grates is at or below the finished floor level.
- D. Drains not functioning properly shall be removed and reinstalled properly at the expense of the Contractor.
- E. Install automatic trap priming system with cabinet where indicated. Install trap primer valves where indicated. Pitch outlet piping from trap primer down toward drain trap a minimum of 1 percent and connect to floor drain body, trap, or inlet fitting. Adjust valve for proper flow.
- F. Install traps for all floor drains connected to the sanitary system.
- G. Install roof drains without traps.

3.3 CLEANOUTS

- A. Install cleanouts in sanitary and storm drainage systems at ends of runs, at changes in direction that are greater than 45 degrees, near the base of stacks, every 50 feet in horizontal runs, and where indicated.
- B. All cleanouts required above food storage, preparation, dining and serving areas shall be extended up through the floor above.
- C. Vertical Pipes: Install cleanout in tees near floor.
- D. Horizontal Pipes: Install cleanouts in wyes or long sweep quarter bends.
- E. Extend cleanouts on concealed piping flush to finished walls, floors and grade.
- F. Waterproofing: Cleanouts puncturing waterproofing membrane shall have flashing clamps.

3.4 SHOCK ABSORBERS

- A. Install shock absorbers at solenoid and fast closing valves, at the top of cold-water risers, at each flush valve or battery of flush valves, and where indicated.

3.5 VACUUM BREAKERS AND BACKFLOW PREVENTERS

- A. Install vacuum breakers on water connections to fixtures and equipment where minimum air gaps required by plumbing code are not possible, on hose bibbs and other outlets to which hoses can be attached, and where indicated on the drawings.
- B. Install backflow preventers where indicated on drawings and where required by code. Install air gap on reduced pressure zone backflow preventer and pipe discharge drain to floor drain. Do not install bypass piping around backflow preventers.

3.6 HOSE BIBBS

- A. Install hose bibbs where indicated on drawings. Locate 2 to 3 feet above floor or deck.

3.7 WATER MIXING VALVES

- A. Install water mixing valve assembly where shown on the drawings.
- B. Mount bottom of cabinet 48 inches above finished floor.
- C. Mount top of mixing valve assembly 60 inches above finished floor.

END OF SECTION 22 40 00

SECTION 23 05 00 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Requirements of this Section are applicable to work in Division 23.
- B. Contract Documents:
 - 1. Unless otherwise modified, drawings and general provisions of the Contract, including provisions of General Conditions, Division 00, and Division 01 govern work under Division 23.
 - 2. Contract drawings for mechanical work are diagrammatic, intended to convey scope and general arrangement.
 - 3. Refer questions involving document interpretation or discrepancies to Contract Officer's Representative (COR) for review and direction.
 - 4. Correct faulty work due to resolving discrepancies without proper approval.
 - 5. Specifications establish quality of materials, equipment, workmanship and methods of construction.
 - 6. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.
- C. Scope:
 - 1. The work in Division 23 includes furnishing and installing the mechanical work complete and ready for satisfactory service.
 - 2. Requirements specified govern work in all sections of Division 23.
 - 3. Some of the work described in this Section is also applicable to the scope of Divisions 25, 26, 27, and 28.

1.2 RELATED DIVISIONS

- A. Division 01 - General Requirements
- B. Division 03 - Concrete
- C. Division 05 – Metals
- D. Division 07 - Thermal and Moisture Protection
- E. Division 08 - Openings
- F. Division 09 - Finishes
- G. Division 10 – Specialties
- H. Division 25 - Integrated Automation

- I. Division 26 - Electrical
- J. Division 28 - Electronic Safety and Security

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with regulations of NFPA, District, GPO Standards and other applicable codes and regulations.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- C. Material and Equipment Requirements:
 - 1. Use products of one manufacturer where two or more items of same kind of equipment are required.
 - 2. Materials and equipment shall have a record of one-year successful field use.
 - 3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
 - 4. Only the manufacturer's equipment upon which, the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
 - 5. Basis of Design Products: Where the Specifications or Drawings name a specific manufacturer's product accompanied by the words "Basis of Design," including make or model number or other designation, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Naming of a Basis of Design product is intended to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. The drawings indicate the general size, configuration, location, connections and/or support for equipment or systems specified with relation to the other building systems.
- D. Workmanship:
 - 1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 - 2. Coordinate work and cooperate with other trades to facilitate execution of work.
- E. Coordination with Other Trades
 - 1. Contractor shall give full cooperation and coordination with other trades and shall furnish any information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 - 2. The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordination adjacent work.
- F. Asbestos or asbestos-containing materials shall not be utilized or allowed on this project. The Contractor shall be rigorous in assuring that all materials, equipment, systems, and components do

not contain asbestos. Any deviations from this exclusion shall be remedied at the Contractor's expense without regard to prior submittal approvals.

- G. Access: The Contractor shall specifically consider all materials and equipment installations and shall coordinate with the work of all trades to ensure easy and unobstructed accessibility of all systems for operations, maintenance, repairs, and replacement. Installation of all specified materials and equipment including but not limited to, equipment, supports, ductwork, pipe, electrical conduit and controls shall be in a manner which will allow complete unobstructed access to all panels, access doors, filter racks, control boxes, controls actuators, sensors, valves, tube bundles and all other items requiring access for operations or maintenance. All items such as controls, actuators and valves which require servicing or manual operations for system use shall be located such as to be accessible without standing on other equipment, whenever it is possible or practical. Any installation of new equipment or materials which causes problems related to access of new or existing equipment shall be disapproved by the COR and re-accomplished by the Contractor.
- H. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- I. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

1.4 ACTION SUBMITTALS

- A. Manufacturer's technical product data, installation instructions and description of accessories for each type to be used and system designation:
 - 1. Certificate of completion of cleaning of water systems.
 - 2. Paint primer and finish coat.
 - 3. Access panels.
 - 4. Concrete compressive strength test.
 - 5. Motors and power factor correction capacitors (submit under section specifying related equipment).
 - 6. Layout drawings for equipment supports.
 - 7. Charts for shutoff valve locations.
 - 8. Operating and maintenance manuals.
 - 9. Statement of field instruction completion.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

A. References:

1. References to standards, codes, catalogs and recommendations are latest edition in effect on date of invitation to bid.
2. Refer to applicable contract drawings and specifications pertaining to other Divisions for conditions affecting work.

B. Definitions: The following are definitions of terms and expressions used in Division 23:

1. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
2. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
3. "Directed" - directed by COR.
4. "Ductwork" - includes ducts, fittings, housings, dampers, supports and accessories comprising a system.
5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
6. "Exposed" - not concealed.
7. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
8. "Indicated" - indicated in Contract Documents.
9. "Piping" - includes pipe, fittings, valves, supports and accessories comprising a system.
10. "Removable" - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
11. "Review" - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

C. Refer to Division 01, "References" for additional definition of terms.

1.8 OPERATION AND MAINTENANCE REQUIREMENTS

- A. Provide Operation and Maintenance Data in accordance with Section 01 78 23, "Operation and Maintenance Data".

1.9 WARRANTY

- A. Deliver to the COR certificates of equipment warranty extending beyond the guarantee period.

PART 2 PRODUCTS

2.1 PAINTING

- A. Schedule

SURFACE	COATS	MATERIAL
Concealed Piping, etc.	1	Primer equivalent to Glidden Devguard 4160

Outdoor Metal, Mill Galvanized	1	Inorganic coating equivalent to Crown 7007VG
Outdoor Metal, Other	1	Primer: Equivalent to Glidden Devgurad 4160
	2	Enamel: Equivalent to Glidden Devflex 4216

2.2 ACCESS PANELS

- A. Access panel products are specified in Division 08.

2.3 FLASHING

- A. Flashing Material:
 - 1. Chloroloy 240.
 - 2. 16-ounce per square foot soft sheet copper.
- B. Counterflashing: 26-gage galvanized steel or 16-ounce per square foot soft sheet copper.

2.4 CONCRETE WORK

- A. Compressive Strength: As specified in Division 03 30 00.
- B. Reinforcing Steel: Yield strength as determined by structural design.
- C. Grout: As specified in Division in Division 05 12 00.

2.5 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

- A. References, Characteristics and Ratings:
 - 1. Refer to Electrical Division for requirements of electrical work including starters specified in the Mechanical Division.
 - 2. Provide motors and other equipment requiring electrical power or control service suitable for the electrical characteristics indicated on the Electrical Drawings.
 - 3. Horsepower indicated is for manufacturer's equipment upon which the specification is based. Submit proposed deviations from these ratings for review by the COR. Pay costs incurred by deviations, which are permitted.
 - 4. Provide motor rated for 200 volts for 208-volt service. Provide 230 and 460-volt rated motors for 240 and 480-volt service. For hermetic refrigeration applications, motor voltages must match service voltage.
 - 5. Brake horsepower at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.15 service factor except where other limits are stated for certain equipment, i.e. fans and pumps, the maximum load percentage shall be as stated under that equipment times the 1.15 service factor. For water or refrigerant cooled motors driving compressors the maximum load percentage shall be 78 percent, 72 percent and 70 percent, for motors with 1.25, 1.35, and 1.4 service factors, respectively.
 - a. For motors operating in ambient conditions of 122 degrees F or above, service factor shall be 1.00.

6. Motors controlled by variable frequency motor controllers (VFMC) shall be inverter type motors, compatible and suitable for operation with the VFMC provided for this project.
 - a. Variable Frequency Motor Controller as Specified in 25 00 00 20.
 - b. Variable Frequency Drive Systems as Specified in 25 00 00 30.
 - c. Horsepower of VFMC shall be same as motor.
 - d. Provide motor with a maintenance free, circumferential, conductive micro fiber shaft grounding ring equal to Electro Static Technology Aegis SGR bearing protection ring to discharge shaft currents to ground.
- B. Overload Protection:
 1. Protect each motor, either individually mounted or in unitary equipment, with overload devices such as fuses, thermal cutouts, or thermal protectors installed in each ungrounded conductor serving each motor. Mount these overload devices in the motor controller or in a control panel in unitary equipment.
 2. For equipment that requires the use of fuses, provide the proper size and type of fuses mounted on accessible fuse blocks, integral to the equipment, wired in accordance with applicable codes.
- C. Construction:
 1. Construct motors in accordance with NEMA Standard Publication MG-1, latest edition, and the applicable IEEE standards.
 2. Frame sizes in accordance with NEMA Standard MG-1 and MG-13, latest editions.
 3. Comply with IEEE 841 for severe duty motors.
 4. Starting torque, NEMA Design B, 2-4 percent slip.
 5. Starting (locked rotor) kVA as required by the driven equipment. On motors with a locked rotor indicating code letter of "F" or higher, the manufacturer shall notify the electrical contractor for circuit breaker adjustment in accordance with Division 26, "Electrical."
 6. Indoor, General Use: Open dripproof construction, 1.15 service factor.
 7. Outdoor, Exposed Motor: Totally enclosed fan cooled construction, 1.15 service factor, stator windings totally encapsulated having non-hygroscopic insulation approved for outdoor use, and double shielded bearings.
 8. Rotor: Random-wound, squirrel cage.
- D. Insulation: NEMA Insulation Class B for operation in 104 degrees F ambient; except NEMA Premium efficient motors and motors used in conjunction with variable frequency motor controllers shall be NEMA Class F insulation with horsepower based on Class B rise.
- E. Where motors operate in a maximum ambient temperature above 104 degrees F, provide motors suitably designed for the ambient temperature indicated, employing a different class of insulation or having a change in frame size, i.e., the ambient temperature plus motor full load temperature rise plus 18 degrees F shall not exceed the temperature rating of the insulation system.
- F. Where motors operate in a maximum ambient temperature above 104 degrees F, provide motors suitably designed for the ambient temperature indicated, employing a different class of insulation or having a change in frame size, i.e., the ambient temperature plus motor full load temperature rise plus 18 degrees F shall not exceed the temperature rating of the insulation system.
- G. Power Factor Correction Capacitors: Three-phase, rated for the applied circuit voltage, fused at 5 KVAR's and above. Employ non-PCB impregnated paper or film dielectric and insulation; installed

in indoor dustproof NEMA Type 12, or outdoor NEMA Type 3R enclosure, depending on location; contain maximum of 3 gallons of a combustible insulating liquid; equipped with integral discharge resistors to reduce voltage to a maximum of 50 volts in three minutes.

- H. Power factor correction capacitors shall be sized by the motor manufacturer. List the capacitor KVAR, the full load current of the motor-capacitor combination to enable proper sizing of the overload protection and the corrected power factor at no load and full load on the shop drawings for the equipment. Do not provide power factor correction capacitors for motors served by a variable frequency motor controller or motors with reduced voltage starting. Do not provide power factor correction capacitors for pumps and fans that have dual motors mounted on a single common shaft and with other drive arrangements that rotate both motors.
1. Individual single speed, non-reversing motors, 5 HP and larger, having a full load power factor of less than 90 percent, shall be supplied by the equipment supplier, with power factor correcting capacitors that correct the full load power factor of the circuit to a minimum of 90 percent and the no load power factor to a maximum of unity.
 2. On single speed, non-reversing motors started by reduced voltage controllers such as star-delta, auto transformer, primary resistor, etc., provide necessary contactors and interlocks to prevent insertion of capacitor until controller and motor are operating in the full run mode. Full load power factor of the circuit shall be a minimum of 90 percent.
 3. Provide power factor correction capacitors on chillers to correct power factor to a minimum of 90 percent when the chiller is operating at full load. The power factor correction capacitors shall be installed to the motor circuit between the starter and motor through the overload protection with wiring and overload sizing as recommended by the chiller manufacturer.
 - a. Install at the factory where available or provide components for field installation under supervision of the chiller manufacturer's representative.
 4. On package or unitized equipment on which motors and controls are factory wired up to a point or points of power connection, install and connect power factor correction capacitors to the motor circuits between the starters and the motors, as part of the factory supplied assembly.
- I. Single Phase Motors:
1. 1/6 Horsepower or Less: Split phase capacitor start, permanent split capacitor or resistance start, capacitor run.
 2. 1/4 and 1/3 Horsepower: Capacitor starts.
 3. Bearings: "Life-time" sealed ball bearing type, oilable ball bearing or sleeve type for radial and thrust loading.
 4. High efficiency energy saving type with a minimum efficiency of 70 percent and a minimum full load power factor of 77 percent.
- J. Three Phase Motors:
1. NEMA Premium efficiency polyphase induction type.
 2. Minimum full load power factor before power factor correction of horizontal and vertical shaft motors shall be as follows:

HP	RPM	Kw	RPS	POWER FACTOR
1/2	3600 and 1800	0.37	60 and 30	70 Percent

3/4	3600 and 1800	0.56	60 and 30	70 Percent
1, 1-1/2 and 2	3600 and 1800	0.75, 1.10 and 1.50	60 and 30	79 Percent
3 to 50	3600 and 1800	2.20 to 190.00	60 and 30	85 Percent

3. Minimum full load efficiency (in percent) of horizontal and vertical shaft motors shall be follows:

Open Dripproof (ODP) Motors

HP	KW	1200 RPM (20 RPS)	1800 RPM (30 RPS)	3600 RPM (60 RPS)
		Minimum Full Load Efficiency (%) (6-Pole)	Minimum Full Load Efficiency (%) (4-Pole)	Minimum Full Load Efficiency (%) (2-Pole)
1	0.75	82.5	85.5	77.0
1-1/2	1.10	86.5	86.5	84.0
2	1.50	87.5	86.5	85.5
3	2.20	88.5	89.5	85.5
5	3.70	89.5	89.5	86.5
7-1/2	5.60	90.2	91.0	88.5
10	7.50	91.7	91.7	89.5
15	11.20	91.7	93.0	90.2
20	15.00	92.4	93.0	91.0
25	18.60	93.0	93.6	91.7
30	22.40	93.6	94.1	91.7
40	30.00	94.1	94.1	92.4
50	37.00	94.1	94.5	93.0

NOTE: Efficiencies are nameplate ratings and must be tested in accordance with IEEE Standard 112, Method B.

Totally Enclosed Fan Cooled (TEFC) Motors

HP	KW	1200 RPM (20 RPS)	1800 RPM (30 RPS)	3600 RPM (60 RPS)
		Minimum Full Load Efficiency (%) (6-Pole)	Minimum Full Load Efficiency (%) (4-Pole)	Minimum Full Load Efficiency (%) (2-Pole)
1	0.75	82.5	85.5	77.0
1-1/2	1.10	87.5	86.5	84.0
2	1.50	88.5	86.5	85.5
3	2.20	89.5	89.5	86.5
5	3.70	89.5	89.5	88.5
7-1/2	5.60	91.0	91.7	89.5
10	7.50	91.0	91.7	90.2
15	11.20	91.7	92.4	91.0
20	15.00	91.7	93.0	91.0
25	18.60	93.0	93.6	91.7
30	22.40	93.0	93.6	91.7
40	30.00	94.1	94.1	92.4
50	37.00	94.1	94.5	93.0

NOTE: Efficiencies are nameplate ratings and must be tested in accordance with IEEE Standard 112, Method B.

4. Measure motor efficiencies as tested in accordance with ANSI/IEEE Standard 112, Test Method B. Do not extrapolate efficiencies from other data. Measure each horsepower size. Submit test data from certified independent testing laboratory of standard manufacturer run per horsepower size.

K. Bearings and Bases:

1. Motors 1/2 through 2 Horsepower: Sealed "life-time" ball bearing or regreaseable ball bearing type with minimum life of 25,000 hours under "V" belt load conditions.
2. Motors 3 through 50 Horsepower: Anti-friction bearings sized for a minimum life of 25,000 hours under "V" belt load conditions or a minimum life of 100,000 hours for a direct connected load. House bearings in a regreaseable race with provision for purging old grease. Preload bearings with a bearing load spring to minimize noise and increase bearing life suitable for radial and thrust loading.
3. Motors for Belt Drive: Cast iron or steel base with slide rails having screw adjustments.

2.6 HANGER ATTACHMENT - Application and Type

- A. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.
- B. Concrete (Existing): Double plated expander type anchors. Phillips, Hilti or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.
- C. Precast Concrete Plank: Drill hole through plank; bolt hanger rod to 4-by-4-by-1/8-inch steel plate on top of plank.
- D. Steel Beams: Iron or steel beam clamps.
- E. Brick or Block Walls: Brackets fastened with self-drilling anchors or toggle bolts, light duty; or through bolts with backplates, heavy duty.

2.7 SLEEVES AND ESCUTCHEON PLATES

- A. Coordinate with Section 07 84 00, "Firestopping" for penetration firestopping installed in fire-resistance rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.
- B. Sleeves for Piping and Conduits - Material and Application.
 1. Galvanized Standard Weight Steel Pipe:
 - a. Floors where pipes will be exposed above the floor.
 - b. Interior concrete walls
 - c. Interior masonry walls.
 2. Galvanized Standard Weight Steel Pipe with Anchor Flange Welded to Perimeter:

- a. Exterior concrete walls.
 - b. Exterior masonry walls.
- 3. 22-Gage Galvanized Steel:
 - a. Stud partitions.
 - b. Suspended plaster and gypsum board ceilings.
- C. Air handling unit casing:
 - 1. 22-Gage Galvanized Steel or Moisture Resistant Fiber or Plastic, equipped with temporary centering caps or bottom flanges secured to forms before concrete is poured: Concrete floors other than post-tension floors, where pipes will be concealed above the floor.
 - 2. Galvanized Standard Weight Steel Pipe or Galvanized Cast Iron Pipe, with Integral Membrane Clamping Ring and Brass or Cadmium Plated Bolts:
 - a. Floors with membrane waterproofing.
 - b. Roofs with membrane waterproofing.
- D. Escutcheon Plates for Piping: Chromeplated brass.
- E. Sleeves for Ductwork: 20-gage galvanized steel.
- F. Sealant:
 - 1. One part polysulfide, equivalent to Pecora Synthacaulk GC24 or polycarbonate equivalent to Proseal 34 for general use.
- G. Grout:
 - 1. Nonshrink, recommended for interior and exterior sealing openings in non-fire rated walls or floors.
 - 2. ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic cement grout.
 - 3. Design Mix: 5,000-psi, 28-day compressive strength.
 - 4. Premixed and factory packaged.

PART 3 EXECUTION

3.1 PAINTING

- A. Paint exposed piping, ductwork, casings, breeching, stacks, conduit, wire troughs, junction boxes, backboxes, equipment in mechanical equipment rooms.
- B. Paint miscellaneous ironwork which is not copper, galvanized, aluminum, and stainless steel.
- C. Touch-up scratches and marred places on factory painted equipment to match finish.
- D. Paint outdoor sheet metal and piping, which is not copper, galvanized, aluminum, stainless steel or lead coated.

- E. Paint outdoor piping that is not copper, galvanized, aluminum, stainless steel, or plastic.
- F. Remove grease, scale, rust, and dirt from work to be painted under this or other parts of the specification.
- G. Do not paint when surfaces are damp, exposed to sun, or when temperature is below 50 degrees F.
- H. Do not paint bearings, lubrication fittings, gages, brass trim, nameplates, or other elements where such application would interfere with operation and maintenance of equipment.
- I. Wash galvanized surfaces with pretreating preparations as directed by paint manufacturer.
- J. Omit primer if equipment has factory shop coat. Finish coats must be compatible with shop coat.

3.2 ACCESS PANELS

- A. Provide access panels or doors that are indicated or required for access to filters, coils, fire dampers, smoke dampers, control devices and to concealed mechanical and electrical devices which may require future inspection, repair or adjustment; and elsewhere as required by applicable codes.
- B. Use ceiling element as access panel in suspended metal pan, lay-in panel, and accessible tile ceilings.
- C. Attach a 1/4-inch diameter color-coded aluminum tag to exposed grid tees or ceiling elements used as access panels and recessed pan doors. Coordinate identification with Section 23 05 53, "Identification for Mechanical Piping, Ductwork, and Equipment."
- D. Acoustic Tile Ceiling: Fit frame with anchoring devices for suspension system. Recessed pan type door with acoustic tile facing.

3.3 FLASHING

- A. Flash conduits, ducts, roof curbs, and pipes projecting through roof or outside walls. Extend flashing 12 inches into roofing materials. Make watertight seal to roof material and pipe, duct or conduit.
- B. Protect sleeve packing and flashing joints with counterflashing. Solder or weld counterflashing to pipe, conduit or duct. Clean joint and coat with zinc dust paint.

3.4 CONCRETE WORK

- A. Location: Equipment foundation pads, equipment housekeeping pads, piers, pedestals, cradles or saddles for tanks, vibration isolation inertia bases, and where indicated under mechanical work.
- B. Perform work in accordance with Division 03.

- C. Bond new work to existing concrete, by approved adhesive or by roughing existing surface to expose aggregate uniformly, then cleaning surface. Key new pads, piers, curbs, and pedestals to concrete floors using expansion bolts.
- D. Bevel exposed vertical and horizontal edges 3/4-inch.
- E. Install grout according to manufacturer's recommendations.
- F. Testing: Test concrete as specified under Division 03.

3.5 MOTORS AND ELECTRICALLY OPERATED EQUIPMENT

- A. Align motor, drives, and driven equipment to avoid excessive strain or wear.
- B. Check belt tension with a tension tester for the deflection force recommended by the manufacturer. Check and adjust tension after several minutes operation and then after eight hours of operation.
- C. Power factor correction capacitors for individual motors are installed and connected under the Electrical Division. Coordinate with the Electrical Contractor.
- D. Install shaft grounding ring on shaft of motors served by variable frequency motor controllers in accordance with manufacturer's recommendations and instructions.

3.6 HANGER ATTACHMENT

- A. Select and install structural attachments for hangers supporting pipes, ducts, conduit and equipment adequately for stresses to which they may be subject and for proper distribution of load to building structural members.

3.7 SLEEVES AND ESCUTCHEON PLATES

- A. Sleeves are not required for core-drilled holes except where sleeves are specified and required to extend above the floor.
- B. Sleeves are not required for floor slabs on-grade.
- C. Install sleeves for pipes and conduits passing through roofs, floors, plaster ceilings, gypsum board ceilings, walls, partitions, air handling unit casings, structural members, and other building parts. Install sleeves in time to permit construction progress as scheduled.
- D. Where ducts pass through walls and floor slabs that require a fire damper or combination fire/smoke damper protection at the penetration, provide removable form to create the opening for duct penetration. The fire damper and smoke damper sleeve shall not be used to form opening.
- E. Install sleeves for ducts passing through roofs, walls, plaster ceilings, gypsum board ceilings, floors, and partitions as follows:
 - 1. Where vermin control is indicated.
 - 2. Roof and walls with waterproofing.

3. Floors.
 4. Smoke barriers.
 5. Fire rated walls.
- F. Install sleeves with length to pass through full thickness of construction.
- G. Provide 1/2-inch minimum clearance between sleeve and conduit, pipe, duct or covering. Center conduit, pipe or duct in sleeve unless otherwise indicated.
1. Insulation thickness specified for use through sleeves requiring vermin proofing shall be as specified but not less than 1-inch minimum thickness. Refer to Section 23 07 00, "Mechanical Insulation."
- H. Install ends of sleeves flush with finished wall surfaces.
- I. Cut sleeves to length for mounting flush with both surfaces except, extend floor sleeves for exposed conduits and pipes 2-inch above finished floor.
- J. Hem edges of duct sleeves extending above floor.
- K. Reinforce sleeves temporarily, if necessary, to preserve accurate shape without distortion during construction.
- L. Grout sleeves in concrete floors, concrete roof slabs and concrete walls into building structure to make joint watertight.
- M. Install escutcheon plates for pipes and conduits at floors, ceilings, walls, and partitions in finished areas unless otherwise indicated.
1. Fit escutcheons around insulation, uninsulated pipe, or conduit.
 2. Outside diameter shall cover sleeve.
 3. Where sleeve extends above finished floor, cover sleeve extension with escutcheon.
 4. Install one-piece escutcheons for new piping.
 5. Install split-plate escutcheons on existing piping.
- N. Pack annular space between sleeve and conduit, pipe, or duct and voids between building construction and conduit, pipe, duct, or sleeves as follows:
1. Firestop equal to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, for the following sleeve locations:
 - a. Where vermin control is indicated.
 - b. Roof and walls with waterproofing.
 2. For the following locations, pack annular space between sleeve and conduit, pipe, or duct and voids between building construction and conduit, pipe, or duct sleeves with industrial felt fire material equal to U.S. Gypsum Thermafiber, caulked at both ends to manufacturer's recommended depth with sealant, or code approved firestopping foam, caulk, or putty that meets ASTM E-814 with UL classification firestopping sealant as specified in Division 07. Sealants shall not contain toxic or flammable solvents and shall not produce toxic or flammable out-gasing during any stage of application, curing, drying or fire conditions.

- a. Floors
 - b. Smoke barriers
 - c. Fire rated walls
- 3. See Section 23 07 00, "Mechanical Insulation," for fire stop insulation on pipes and ducts through sleeves.
- O. Vermin Control: Provide vermin control for conduits or pipes passing through ceilings, walls, and partitions.
- P. Prime surfaces prior to caulking to obtain good adhesion where recommended by sealant manufacturer.
- Q. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
 - 1. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.8 CONTRACTOR'S INSTALLATION DRAWINGS

- A. These drawings shall not be construed as shop drawings that require review and action by the COR.
- B. Submit, prior to installation of mechanical systems, six copies of composite working drawings prepared in coordination with other trades at a scale not less than 1/2-inch = 1-foot, clearly showing how work is to be installed in relation to the work of all trades. Contractor shall assist in working out congested space conditions to make a satisfactory adjustment. Drawings shall show the work of all trades (ductwork, conduit, piping, plumbing, lights, equipment, sprinklers, electrical work, etc.) exposed and concealed, including existing mechanical, plumbing, fire protection, and electrical services, coordinated with each other and with the structure. Drawings shall be submitted and bear the COR's review stamp before any materials are ordered or fabricated.
- C. Work installed before coordinating with other trades or as to cause any interference with work of other trades shall be changed by the Contractor to correct the conditions at their expense.
- D. Drawings shall show existing services where clearances for access are to be maintained.
- E. Relocate existing work or modify location of new work as required to maintain required access and code clearances.

3.9 PROJECT RECORD DOCUMENTS

- A. Maintain at the site one set of black or blue line on white prints of drawings, copies of specifications, addenda, shop drawings reviewed by COR, change orders and other modifications in good order and marked in red ink to record changes made during construction. Deliver these in final complete form to the COR upon completion of work.

3.10 MATERIAL AND EQUIPMENT LIST

- A. Submit for COR's review a list of subcontractors' and manufacturers' names for items proposed for the work within 30 days after award of the contract.
- B. Failure to submit list or name manufacturers acceptable to COR within time limit will result in COR selecting a list of manufacturers, and selection shall be binding upon Contractor.

3.11 SHOP DRAWINGS AND DESCRIPTIVE DATA

- A. Submit electronic copies, in accordance with Division 01, of manufacturer's shop drawings and descriptive data.
- B. Establish that the physical and functional character of each item including, size, type and required service access is suited for its intended location and use.
- C. Coordinate drawings and data before submitting and certify that provisions of the contract documents have been met.
- D. Call attention, in writing, to deviations from contract requirements.
- E. Do not fabricate, deliver to site, or install items requiring shop drawing review, until the review has been completed by the Engineer and the shop drawing has been marked to indicate "No Exception Noted" or "Make Corrections Noted."
- F. Specifically identify pertinent project data on the shop drawings.
- G. Include Operation and Maintenance Data.
- H. Use only final or corrected drawings and data for construction.

3.12 SITE EXAMINATION

- A. Failure to visit site and become familiar with local conditions prior to bidding will not relieve the Contractor of their responsibility for complying with the Contract Documents.

3.13 PERMITS

- A. Obtain and pay for required permits including those required by air and water quality control regulations.

3.14 CUTTING AND PATCHING

- A. Unless otherwise directed, do cutting and patching. Repair damaged fireproofing and waterproofing to original or better condition.
- B. Do not cut walls, floors, reinforced concrete or structural steel without COR's permission. Install services without affecting reinforcing steel.

- C. In precast concrete plank, drill holes with a carboloy tipped drill. Follow instructions of plank manufacturer. Cut no reinforcing bars.

3.15 CLEANING UP

- A. Keep premises free from accumulation of debris.
- B. Remove tools, scaffolding, surplus material, debris, and leave premises broom clean.
- C. On discontinuance of part of the work, place debris in containers and promptly remove them from the Government's property.

3.16 WORK IN EXISTING BUILDINGS

A. Conditions of Occupancy:

1. This building will be occupied during the life of this contract. Execute work in a manner to impose minimal interference with the normal functioning of the building and its occupants. When interference is unavoidable, schedule work 14 days in advance with the COR.
2. Make temporary connections where necessary to maintain uninterrupted electrical and heating service.
3. Provide adequate protection for the building, its contents, and occupants.
4. Perform work as quietly as possible to avoid unnecessary disturbance. Unusual precaution may be necessary in the conduct or work in some areas to achieve satisfactory compliance.
5. Coordinate with COR to perform masonry demolition or other work producing high noise levels, dust, or hazards to occupants in occupied areas.
6. Comply with regulations of COR pertaining to circulation, sanitation, and behavior of Contractor's personnel.
7. Minimum use of impact tools shall be limited to handheld tools and shall be scheduled 14 days in advance with COR.
8. Also see Division 01, "General Requirements".

B. Temporary Use of Elevator:

1. Use only the elevator(s) designated by the COR for Contractor's use in accordance with the COR's instructions for use.
2. Protect elevator cab with temporary wood lining on floors, walls, and ceiling throughout period used. Upon completion of construction, restore cab to substantially equal condition as existed prior to Contractor's use. Operate elevator(s) during period complying with regulations governing usage.

C. Field Office, Storage, and Loading Facilities:

1. Provide office and storage facilities where designated by the COR.
2. Provide adequate furnishings including file space, lighting, telephone, and heat where necessary.
3. Use only those toilet facilities designated by the COR for use by Contractor's personnel.
4. Store equipment and materials in areas designated by COR in a manner which will not (a) cause concentrations of weight potentially damaging to building structure, (b) impede normal building traffic, or (c) be a hazard to occupants.

5. Use only the entrance designated by the COR for delivery and removal of materials. Schedule deliveries and removals with the COR in advance. Unscheduled traffic must give precedence to Government's usage. Do not impede access through doorways and corridors with materials, containers, or parked conveyances.
6. Use only rubber wheeled wheelbarrows, dollies, or carts over finished floors.
7. Keep office, storage, and loading areas neat and clean.

D. Temporary Heat:

1. Where existing heating is removed or temporarily discontinued, provide temporary heat to protect the building elements, to permit proper conduct of work, and to maintain occupied
2. Do not use new heating systems without written permission of the COR, and if used (a) pay energy costs, (b) do not operate without air and water filters, water treatment, or prior to flushing of piping, and (c) place in as good as new condition including new filters and clean apparatus prior to Government acceptance. Guarantee period shall not be shortened by such operation.

E. Barricades:

1. Erect temporary barriers for protection of occupants, building, and building contents.
2. Where partitions separating occupied areas must be cut, close hole with tight fitting temporary plywood closure panel, 1/2-inch minimum thickness, to form visual and acoustical barrier.
3. Protect exposed holes in floors in accordance with applicable codes and regulations.
4. Enclose dust-producing operations with plastic sheets or drop cloths to prevent the spread of dust into occupied areas. Maintain a negative pressure environment relative to the surrounding spaces.
 - a. Take the necessary precautions to prevent the spread of dust and dirt through the existing HVAC system, including outdoor intakes. Protect new and existing return and exhaust air openings.

F. Alterations:

1. Cut, alter, remove or temporarily remove and replace existing work necessary for installation of mechanical and associated electrical work. Maintain the necessary clearances for accessibility or compliance with code around existing equipment, devices, etc., that are to remain.
2. Verify dimensions of existing building elements pertaining to the installation of new work to assure physical compatibility prior to fabrication or installation.
3. Where the installation of new services or the extension of existing services requires cutting of existing floors, walls, partitions, etc., check for the presence of existing fire suppression, plumbing, mechanical and electrical services within or immediately beneath construction and exercise necessary precautions to prevent damage to the service or injury to personnel due to contact with same. Where practical, temporarily disconnect such existing service during the cutting operation. Schedule such outages in service with the / COR/ 14 days in advance.
 - a. Unless otherwise indicated, removal of pipes, ducts, and equipment includes removal of accessories such as hangers, air outlets, piping connections, junction boxes, starters, etc./ and all abandoned and non-operational mechanical system components within limits of the contract/. Remove to source or, if concealed, to point of concealment, connections to mechanical equipment required to be removed or disconnected. Terminate connections behind finished surfaces and, if subject to

movement, clear of building construction. Cap connections extending from ducts or piping remaining in service.

- b. Contractor shall mark all components to be removed and obtain confirmation from GPO Engineering Operations prior to demolition.

- G. Roof Protection: The Contractor shall provide full temporary roof protection for the building's existing roof system during all construction which involves construction on the facility roof. Protection shall consist of full area mats, plywood and other protection devices. No construction shall be performed on areas without protection devices in place. No regular traffic directly on the existing roof shall be permitted. Provide roof guard protection pads for all roof top equipment installed under this contract. Pads shall be compatible with the existing roof system. Roof guard pads shall be 3/4-inch thick, textured surface non-skid type. Construction shall be rubber or neoprene materials. Pads shall be minimum 4-by-5 feet units and shall be secured to the existing roof with compatible adhesives. Pad surface shall be heavy duty, damage resistant. Provide a minimum of 300 square feet of pad for each piece of roof top equipment. Install pads immediately adjacent to equipment; at all regular maintenance locations; and probable walkways to the equipment. Install and secure in accordance with the manufacturer's instructions.

H. Connections to Existing Systems:

1. Connect to existing systems as indicated.
2. Obtain permission from COR 14 days in advance if outage of service is necessary to make connections. See the Article titled, "Outages."
3. Repair insulation damaged at points of connection. Restore integrity of vapor barriers and surface finish.

3.17 PROTECTION

- A. Protect mechanical and associated electrical material and equipment from the elements or other injury as soon as delivered on premises.
 1. Accept in original packaging.
 2. Store in clean, dry space.
 3. Protect from dirt, water, construction debris, and traffic.
 4. Handle in accordance with manufacturer's written instructions.
- B. Cap or plug openings in equipment, piping, duct, and conduit systems, to exclude dirt and other foreign material. Do not use rags, wool, cotton, paper, waste or similar materials for plugging.
- C. Existing components of the building and its systems shall be protected from damage. Any damage to these components shall be repaired or replaced to the satisfaction of the COR. Special care shall be taken with regards to insulation on existing piping and ductwork. Damaged insulation shall be replaced so that the vapor barrier and insulating characteristics of the material match those prior to damage taking place.

3.18 ASBESTOS

- A. Should material resembling asbestos-containing materials be encountered during execution of work, immediately notify COR for instructions before proceeding.

3.19 CLEANING OF SYSTEMS

- A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior are free of foreign matter.
- B. Flush piping in recirculating water systems to remove cutting oil, excess pipe joint compound, and other foreign materials. Provide necessary temporary pumping equipment to thoroughly clean the water piping. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the COR. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. Discharge flushing solution to sanitary piping system and not to floor drains connected to storm water systems. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Work shall be performed or supervised by a qualified water treatment service company with personnel skilled in the safe and proper use of chemicals and in testing procedures. Submit a certificate of completion to COR stating name of service company used.
- C. Leave strainers and dirt pockets in clean condition.
- D. Clean fans, ductwork, enclosures, flues, registers, grilles, and diffusers at completion of work.
- E. Install air filters of equal efficiency to those specified in permanent air systems operated for temporary heating or air balancing during construction. Install water filters of equal efficiency to those specified in permanent water systems operated for temporary heating and cooling or water balancing during construction. Replace with clean filters as specified prior to acceptance and after cleaning of system.
 - 1. Replace existing filters in existing systems serving the renovated areas at the discretion of the COR that may have become loaded due to renovation work.
- F. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.
- G. Leave systems clean, and in complete running order.
- H. Disinfect potable water systems as prescribed by local code. Take precautions to avoid use of fixtures during disinfecting period. The disinfecting shall be performed by water treatment company selected for water treatment under Section 23 05 00 -" Water Treatment Systems".

3.20 EQUIPMENT SUPPORTS

- A. Provide equipment supports consisting of platforms, curbs, concrete pads, gratings, cradles, structural members, hangers, rods, racks, and incidental materials.
- B. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas.
- C. Concrete Equipment Pads

1. Provide concrete pads not less than 4 inches high and projecting not less than 3 inches on all sides beyond equipment for floor mounted equipment.
 2. Place anchor bolts in steel pipe sleeves, with a plate at bottom end of sleeve to hold bolts.
 3. Grout between base plate and foundation.
- D. Floor Mounted Stands: Construct with structural steel members or steel pipe and fasten with flanges bolted to floor.
- E. Curbs: Construct concrete curbs 4 inches high and 6 inches wide unless otherwise indicated. Plenum curbs shall be sealed air and water tight for conditions of the plenum operating pressure.
- F. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.
- G. Wall Mounted Platforms: Construct with steel brackets.
- H. Saddles for Tank Supports: Cast iron or welded steel of curvature to fit tank. Locate supports to avoid undue strain on shell and interference with pipe connections to tank outlets.

3.21 OPERATING AND MAINTENANCE MANUAL

- A. Furnish manual bound and indexed containing:
1. Brief description of each system and components.
 2. Starting and stopping procedures.
 3. Day/night changeover.
 4. Seasonal changeover
 5. Special operating instructions.
 6. Routine maintenance procedures.
 7. Schedule for periodic servicing and lubrication.
 8. Manufacturers' printed operating and maintenance instructions, parts lists, illustrations and diagrams.
 9. Manufacturers' Data Report Form U-1 certifying code compliance for equipment specified to be constructed in accordance with ASME Code for Unfired Pressure Vessels.
 10. One final or corrected reviewed copy of each shop drawing and Contractor's drawings.
 11. One copy of each wiring and piping diagram.
 12. One reviewed copy of certified test reports.
 13. Air and water balancing report.
 14. Product warranty information.
 15. Completed start-up report: See 23 08 16 for equipment to be commissioned.
- B. Submit to COR for review at least 30 days prior to date it is expected system will be turned over to the Government.
- C. After review by COR, submit three copies to COR and one to Engineer of Record.

3.22 FIELD INSTRUCTION

- A. Provide operating and maintenance staff demonstrations and training in accordance with Section 01 79 00, "Demonstration and Training".

1. Provide a walking tour, demonstrating all new mechanical equipment, system layout, routing and labeling.
- B. Upon completion of work, instruct Government's representatives in the proper operation and maintenance of the mechanical systems.
- C. Instruction periods specified below shall be in addition to instructions specified for certain items elsewhere in the specifications.
- D. Instructions shall be given by persons' expert in the following systems and equipment and shall include descriptions and demonstration of procedures, data logging, and analysis.
 1. Cooling Plant: Including refrigeration plant, cooling tower, pumps, related equipment, water treatment, safety controls. Provide 8 hours of instruction.
 2. Air Systems: Including air handling units, heating and cooling coils, filters, fans, safety controls and other air handling equipment. Provide 8 hours of instruction.
 3. Automatic Control: Including operating controls for heating, cooling, ventilating systems, control centers, panels, compressed air system. Provide 8 hours of instruction.
 4. General Instructions: Including review of written operating instructions and balancing report, miscellaneous instructions. Provide 8 hours of instruction.
- E. Prepare statement(s) for signing by Government's representative indicating date of completion of instructions and hours expended. Furnish copy of signed statement to COR.
- F. Training of the Government's operation and maintenance personnel is required in cooperation with the Commissioning Authority. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in cooperation with the Commissioning Authority after submission and approval of formal training plans. Refer to Section 01 77 00 "Project Closeout", for contractor training requirements. Refer to Section 23 08 16, "Commissioning of HVAC Systems", for further contractor training requirements.

3.23 CONTRACTOR TESTS

- A. Contractors' tests shall be scheduled and documented in accordance with the Commissioning requirements. Refer to Section 23 08 16, "Commissioning of HVAC Systems", for further details.

3.24 VERIFICATION TESTING

- A. System verification testing is part of the Commissioning process. Verification testing shall be performed by the contractor and witnessed and documented by the Commissioning Authority. Refer to Section 23 08 16, "Commissioning of HVAC Systems" for system verification tests and commissioning requirements.

3.25 OUTAGES

- A. The purpose of this article is to establish standard procedures for requesting an outage for mechanical, electrical, or operational systems or services associated with the building.

- B. An outage is defined as prohibiting or restricting a mechanical, electrical or operational service from routine operation (see attached outage request for service included). For purposes of repair, replacement or connection to an existing system, this standard shall be followed.
- C. All persons requesting an outage shall complete an "Outage Request Form" included at the end of this Section.
- D. Contractor shall submit, in writing with the "Outage Request Forms" a plan on the work to be performed during the outage, including length of time and reason the utility system must be shutdown. Contractor, in conjunction with the COR, shall research and identify all systems affected by Outage as well as locating and listing all components by tag or facility equipment number, and all the action required at each to achieve the outage. Submit per Division 1 "General Requirements" in advance of requested outage to COR.
- E. All "Outage Request Forms" and the Outage Plan shall be reviewed by the construction foreman or superintendent for feasibility and necessity.
- F. All "Outage Request Forms" and the Outage Plan shall be forwarded to the "Plant Operations and Maintenance Manager" for review and approval prior to scheduling. Contractor shall attend weekly Outage Review Meetings and be prepared to answer questions and discuss the plan.
- G. After approval by the Plant Operations and Maintenance Manager, the outage shall be scheduled by either the Buildings or Utilities Superintendent (according to the services requested for outage). Government's representative will notify the Contractor, in writing, to proceed. No outage shall proceed prior to written notification from the Government's representative.
- H. All systems, when shutdown, shall be tagged in accordance with OSHA, lock-out/tag-out procedures.
- I. The number and duration of all outages shall be minimized.
- J. A master outage list, with the approximate required dates, shall be submitted to the COR within 14 days from the commencement of work.

Attachments: Outage Request Form

END OF SECTION 23 05 00

OUTAGE REQUEST FORM

DATE: _____

OUTAGE REQUESTED BY: _____

DEPARTMENT/COMPANY NAME: _____

PURPOSE OF OUTAGE: _____

DATE NEEDED: _____

BUILDING AFFECTED: _____

AREA WITHIN BUILDING TO BE AFFECTED: _____

THE FOLLOWING SERVICES ARE REQUESTED TO BE REMOVED FROM SERVICE:

_____ HOURS

- | | | |
|----|------------------------------|-----------------------------------|
| a. | ___ FIRE PROTECTION | ___ SPRINKLER |
| | | ___ HOSE CABINET/STANDPIPE SYSTEM |
| b. | ___ COLD WATER (DOMESTIC) | |
| c. | ___ SANITARY SEWER | |
| d. | ___ HOT WATER (DOMESTIC) | |
| e. | ___ STEAM | |
| f. | ___ CHILLED WATER | |
| g. | ___ HEATING WATER | |
| h. | ___ AIR HANDLING SYSTEMS | |
| i. | ___ ELEVATOR | |
| j. | ___ NORMAL ELECTRIC POWER | ___ LIGHTING |
| | | ___ POWER |
| k. | ___ EMERGENCY ELECTRIC POWER | |
| l. | ___ ASBESTOS REMOVAL | |
| m. | ___ NATURAL GAS | |

SECTION 23 05 48 - MECHANICAL SOUND AND VIBRATION CONTROL

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Vibration isolation devices, accessories, and supports to prevent transmission of vibration from mechanical and electrical equipment and distribution systems to building structure.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 – Basic Mechanical Materials and Methods
- C. Section 23 20 00 – Building Services Piping
- D. Section 23 21 13 – Hydronic Pumps
- E. Section 23 31 13 – Ducts and Duct Accessories
- F. Section 23 34 16 – Fans
- G. Section 23 64 16 – Liquid Water Chillers
- H. Section 23 65 13 – Packaged Cooling Towers
- I. Section 23 73 13 13 – Indoor Basic Air Handling Units
- J. Section 23 73 13 – Air Rotation Units
- K. Section 23 3 43 – Outdoor Custom Air Handling Units
- L. Section 23 82 29 – Unit Heaters

1.3 QUALITY ASSURANCE

- A. The vibration isolator manufacturer's representative shall determine spring sizes and mountings, and shall provide field supervision and inspection to assure proper installation, adjustment and performance. The representative shall notify the Contracting Officer's Representative (COR) of any isolator selections, which may experience resonance with the approved equipment, and upgrade any isolators that are found to resonate with the installed and operating supported equipment.
- B. Vibration isolation mounts, hangers, and equipment bases for Division 22 and 23 work shall be from the product line of a single manufacturer or products represented by the same manufacturer's representative.

- C. Work shall be performed by skilled workers who are experienced in the necessary workmanship to meet the requirements of this Section.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Vibration Isolation Product Data:
 - 1. Manufacturer's technical project data for each type of vibration isolation, including installation instructions, accessories, supports, bases, fittings, finishes, construction details and dimensions of components.
 - 2. System application for each type of vibration isolation.
 - 3. Operation and Maintenance Data
- C. Operation and Maintenance Data.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Schedule of Equipment Isolation is included in this Section.
- B. Wind-Restraint Loading:
 - 1. Three-second Wind Gust Speed: 115 mph.
 - 2. Building Occupancy Category: II.
 - 3. Exposure Category: C.
 - 4. Minimum 10 lb/sq. ft. multiplied by maximum area of the HVAC component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.7 VIBRATION ISOLATION MANUFACTURER'S RESPONSIBILITY

- A. Select vibration isolators, which will enable the noise criteria standards to be met, to the extent that the noise can be controlled by the vibration isolators. Determine vibration isolation sizes and locations.
- B. Furnish vibration isolation systems as scheduled or specified.
- C. Guarantee specified isolation system deflection.
- D. Provide installation instructions, drawings and field supervision to assure proper installation and performance. The installation of all vibration isolation units, and associated hangers and bases, shall be under the direct supervision of the manufacturer's representative. Upon completion of

installation and after system is put into operation, representative shall make a final inspection and submit his report to the COR in writing certifying correctness of installation and compliance with reviewed submittal data.

1.8 CONTRACT CLOSEOUT

A. Provide the following in the Operating and Maintenance Manuals:

1. Final inspection report from manufacturer's representative.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATION DEVICES

- A. Select isolators for uniform static deflections according to distribution of weight and to meet requirements shown elsewhere in the Contract Documents.
- B. Select isolators for not less than the deflections indicated on the Schedule.
- C. Select vibration isolation for stable operation during starting and stopping of equipment without excessive movement of equipment.
- D. Bases:
 - 1. Provide rectangular bases, unless indicated otherwise.
 - 2. Provide perimeter side mounted unhoused isolators with brackets arranged for 1-1/2-inch clearance beneath base.
- E. Corrosion Resistance: All springs and associated metal hardware shall be designed or treated for resistance to corrosion. Steel components shall be PVC coated, or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc electroplated. Structural steel bases and exposed steel components of concrete inertia bases shall be cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.
- F. Outdoor Locations: Steel parts PVC coated, hot-dip galvanized, zinc-electroplated plus coating of neoprene, bitumastic paint, or powdered coating. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel. Nuts, bolts, and washers may be zinc-electroplated.

2.2 MOUNTINGS

A. Type A:

1. Double deflection neoprene, friction surfaces on top and bottom, bolt holes, and threaded steel top inserts. Design for 0.25 - 0.35-inch deflection at rated load. Maximum hardness shall be 40 durometer. Color code to identify durometer. Except where rails are integral with

equipment, provide steel rails to distribute load. Extend rails to compensate for overhang on close coupled pumps, small vent sets. Mason Industries Type ND.

B. Type B:

1. Springs, free standing, laterally stable, without housing, 1/4-inch minimum thickness neoprene pads between baseplate and supports sized for deflection of 10-20 percent of unloaded pad height; leveling bolts. Spring diameters not less than 0.8 times compressed spring height at operating load. Springs shall have minimum additional travel to solid equal to 50 percent of operating deflection. Springs shall be designed so that the ratio of horizontal stiffness to vertical stiffness is approximately one. Mason Industries Type SLF:
 - a. If the mount baseplate is to be bolted to structure or framework rigidly connected to the structure, elastomeric grommets shall be used as specified under Paragraph 3.2.

C. Type C:

1. Springs, same as Type B except with non-captive housing with vertical travel limit stops to prevent upward movement due to weight change or wind loading. Use housing as blocking during erection; installed and operating heights shall be the same; 1/2-inch clearance around restraining bolts and between housing and spring. Limit stops shall be out of contact during normal operation. Mason Industries Type SLR.

D. Type D2:

1. Same as Type D except with a cemented steel plate on top with a 3/4-inch diameter center hole for bolting through. Include a 3/4-inch Neoprene isolation washer cemented to a steel washer is provided as well. Mason Industries Type MBSW and Type HLW.

E. Type E:

1. Closed cell neoprene strip, 4 inches wide, 3/4-inch high.

2.3 HANGERS

A. Type G:

1. Combination spring and double deflection neoprene in series, 0.30-inch minimum deflection for neoprene element. Spring diameter not less than 0.8 times compressed spring height at rated load. Springs shall have minimum additional travel to solid equal to 50 percent of rated deflection. Design shall allow for 15-degree misalignment from vertical before contact of housing and hanger rod. Mason Industries Type 30N.

B. Type H:

1. Same as Type G except with spring deflection indicator, precompressed springs to support object at fixed elevation during installation. Mason Industries Type PC30N.

C. Type I:

1. Spring hangers with rubber on neoprene grommet. Springs same as Type G. Mason Industries Type HS.

D. Type J:

1. Thrust restraints shall be in sets of two or more, and shall be springs in series with neoprene. Deflection shall be equal to deflection of isolators supporting the unit being restrained. Provide thrust restraints complete with rods and adjustment nuts, plus angle brackets and backing plates for attachment to the unit being restrained and anchor supports. Mason Industries Type WB series.

2.4 BASES

A. Type L:

1. Unitized rectangular structural steel base. WF perimeter beams with minimum depth equal to 0.10 times longest base dimension (6 inches minimum depth). Spacing between isolators shall be a maximum of ten times the depth of the base. Mason Industries Type WFSL.

B. Type M:

1. WF structural members welded to brackets to form rigid saddle supports. Mason Industries Type ICS.

C. Type N:

1. Reinforced concrete base in structural channel frame. Minimum depth 6 inches, but not less than 0.085 times longest base dimension. Frame with reinforcing bars or angle base stiffeners welded in place running both ways in layer 1-1/2 inches above bottom with drilled steel members with sleeves to receive equipment anchor bolts. Base frame and reinforcement shall be furnished by isolator manufacturer of structural design suitable for indicated duty. Maximum spacing between isolators shall be ten times the depth of the base. Mason Industries base form Type K.

D. Type P:

1. Curb mounted rooftop equipment isolation bases constructed to fit the top of standard curbs and match the underside of the isolated equipment. Aluminum construction welded in the corners to provide weather tightness. Flexible neoprene connection weather seal. Cadmium plated steel springs. Spring stability shall provide horizontal wind resistance. Install assembly with rubber blocks located in each corner between the two frames. Mason Industries CMAB.

2.5 HOSES

A. Type S:

1. Metallic, flexible bellows type bronze hose with bronze braid or Type 321 stainless steel hose with stainless steel braid. Bronze for application with copper tubing and brass piping;

- stainless steel for ferrous applications. Hose shall have weld, thread, flange or sweat connections as required for piping or tubing connection application.
2. Hose length shall be a minimum length of 9 inches.
 3. For freon refrigeration service, hose shall have adequate pressure rating for compressor discharge service working pressure of 300 psig at 250 degrees F; suction service working pressure of 200 psig at 100 degrees F.
 4. For other services, 6-inch and smaller 205 psig at 350 degrees F.
 5. Mason Industries/Mercer Rubber Type BBS stainless, CPS bronze.

B. Type T:

1. Flexible single or double sphere type flanged connectors. Manufactured with multiple ply, nylon tire cord fabric that has an inner liner and outer cover of neoprene or EPDM. Sphere flange shall have an internal steel cord or band to prevent sphere separation from mounting installation flange. Working pressure shall be 150 psi at 220 degrees F for pipe sizes through 12 inches, and 100 psi at 220 degrees F for pipe sizes larger than 12-inch diameter.
2. Sphere shall be suitable for application with unanchored piping with piping on isolation hangers and pumps on isolated base. Provide control rods or cables unless sphere is specifically designed and rated by the manufacturer for installation without control rods and cables. Provide installation instruction to clearly indicate if rods or cables are required and if pre-extension is required. This information shall be included in shop drawing submittal.
3. General Rubber 1010 single sphere; 1020 and 1030 double sphere /Mason MFNC, MFTNC, and MFTFU.

2.6 ELASTOMERIC GROMMETS

- A. Type U: Grommets shall be a separate bushing with a separate washer or combination neoprene washer/bushing. Grommets shall be formed to prevent bolts from directly contacting the secured item. Elastomer shall be 56 durometer maximum. Mason Industries Type HLB bushing with HLW washer or HG washer/bushing.

2.7 ACOUSTICAL SEALANT

- A. Sealant for acoustical purposes, as described in this Section, shall be silicone or one of the non-setting sealants listed under the Article titled "Manufacturers" in Part 2 of this Section.

2.8 RESILIENT PENETRATION SLEEVE/SEAL

- A. Field fabricate from pipe or sheet metal section 1/2 to 3/4-inch larger in each dimension than penetrating element in all direction around the element. Use to provide a sleeve through the construction penetrated. Extend sleeve 1-inch beyond the penetrated construction on each side. Pack annular space between sleeve and the penetrating element tightly with glass fiber or mineral wool to within 1/4-inch of ends of sleeve. Fill remaining 1/4-inch space on each side with acoustical sealant to form an airtight seal. Penetrating element shall be able to pass through sleeve without contacting sleeve. Alternatively, prefabricated sleeves accomplishing same result are acceptable. Mason Industries Type SWS
- B. Do not use at fire-rated penetrations.

2.9 MANUFACTURERS

- A. Mountings, Bases, Hangers, and Resilient Sleeves: Amber-Booth, /Kinetics Noise Control, Inc. Korfund, Mason Industries, Vibration Eliminator, Vibration Mountings and Controls, Vibrex.
- B. Hoses: Amber-Booth, General Rubber, Mason-Mercer Rubber, Metroflex.
- C. Grommets: EAR Specialty Composites Corp., Gates Molded Products, Mason Industries, Tech Products Corp., Vibration Mountings and Controls, Vibrex.
- D. Acoustical Sealants: DAP, Pecora, Tremco, USG.

PART 3 EXECUTION

3.1 VIBRATION ISOLATION DEVICES

- A. Install in accordance with manufacturer's recommendations. Corrosion coatings damaged during installation shall be repaired.
- B. Install isolators in locations to permit inspection and adjustment, and to provide proper operation. Install isolators as high as possible in hanger rod assembly, but clear of structure. Maintain 2-inch clearance between isolated equipment and walls, ceilings and other equipment. Maintain side clearance for hanger housings to allow a full 360-degree hanger rotation about the rod axis without contacting any object. Isolated systems shall be independently supported.
- C. Adjust leveling bolts and hanger rod bolts so that isolated equipment is level and in proper alignment with connecting ducts and pipes. All vibration isolators shall be aligned squarely above or below mounting points of supported equipment.
- D. Install isolators to provide 1-1/2-inch clearance between inertia base or frame and housekeeping pad. Keep clearance space completely clear of debris. Limit stops shall be out of contact during normal operation.
- E. Provide structural base plate under isolator where isolator is wider than supporting structural member. Tack weld plate to structural member.
- F. Where necessary, provide lateral snubber or Type J thrust restraint isolation, which will not interfere with main isolator performance, to prevent movement in excess of 1/4-inch due to dynamic forces.
- G. Mount equipment on steel base of adequate structural rigidity when equipment or frame is not structurally suitable for the type of isolation specified. Spring and rail and spring supports are specified on the basis that the equipment is structurally built or supported on a rigid frame. Isolators for equipment with bases shall be located on sides of the base, which are parallel to the equipment shaft.
- H. Comply with requirements in Section 07 72 00, "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

3.2 EQUIPMENT ISOLATION SCHEDULE

- A. If the mount baseplate is bolted to structure or framework rigidly connected to the structure, Type U elastomeric grommets shall be used between each bolt and the baseplate to prevent rigid connection. These additional neoprene washers and bushings may be omitted if the baseplate and friction pad incorporate neoprene elements that eliminate rigid contact between bolts and the baseplate. Bolt holes shall be properly sized to allow for bushing sleeve. The anchor bolt shall incorporate steel washers to distribute load evenly over neoprene washers.

- B. Isolation Schedule:

TYPE OF EQUIPMENT	SUPPORTING STRUCTURE			
	FLOOR SLAB ON EARTH		OTHER FLOOR AND ROOF	
	ISOLATION BASE TYPE	MIN. STATIC DEFLECTION IN INCHES	ISOLATION BASE TYPE	MIN. STATIC DEFLECTION IN INCHES
Centrifugal Chillers				
Hermetic	-	-	C	1.5
Air Compressor				
Rotary Air Compressor	-	-	A+M	0.5
Pumps				
Closed Coupled (Base Mounted)				
thru 7-1/2 HP	-	-	B+N	1.0
10 HP and Up	-	-	B+N	1.75
End Suction: Vertical Split Case (Base Mounted) and Vertical In-Line Pump				
thru 15 HP	-	-	B+N	1.0
20 HP and Up	-	-	B+N	1.75
Blower Coil Units				
Suspended				
thru 5 HP	-	-	G	1.0 (Note 1)
Axial, Tubular and In-line Centrifugal Fans				
Suspended (Note 4)				
225-349 rpm	-	-	G	3.5
350-499 rpm	-	-	G	2.5
500 rpm and Over	-	-	G	1.5
Utility Sets				
Floor Mounted with a Wheel Diameter of 18 inches and Larger				
Less than 500 rpm	-	-	B+L	2.5 max
500 rpm and Over	-	-	B+L	1.5
Floor Mounted with a Wheel Dia. Less than 18 inches	-	-	B+L	1.5 max (Note 1)
Cooling Towers				
225-349 rpm	-	-	C	3.5
350-499 rpm	-	-	C	2.5
500 rpm and Over	-	-	C	1.5
Split System Air Cooled Condensing Units	-	-	D2	0.1
Roof-Mounted Packaged Equipment	-	-	P	1.0

TYPE OF EQUIPMENT	SUPPORTING STRUCTURE			
	FLOOR SLAB ON EARTH		OTHER FLOOR AND ROOF	
	ISOLATION BASE TYPE	MIN. STATIC DEFLECTION IN INCHES	ISOLATION BASE TYPE	MIN. STATIC DEFLECTION IN INCHES
Horizontal Unit Heaters – Suspended	-	-	G	1.0 (Note 1)

NOTES:

- (1) Spring Deflection
- (2) Not Used.
- (3) Not Used.
- (4) When fan is suspended, the specified isolation shall be provided in the suspension framework.

3.3 PIPING ISOLATION

- A. Provide isolators for supports of all piping (except at anchor points and at base elbow supports for main risers) connected to vibration isolated equipment:
 1. Throughout mechanical equipment rooms but, not less than 50 feet from the isolated equipment where the first 50 feet extends past the mechanical equipment room wall. The pipe shall not come in contact with the wall or sleeve.
 2. For the first 50 feet if not in a mechanical equipment room.
 3. Within 50 feet of pressure reducing valves.
 4. Between cooling tower and entrance into building.
- B. The minimum static deflection of the first three hangers shall equal that of the isolators supporting the equipment. Thereafter, provide isolators with 1/2 the static deflection capabilities of the isolation system of the equipment to which it is connected.
- C. Type A or B Mountings: Provide on all floor-supported piping.
- D. Type G Hanger Isolators: Provide on all suspended piping, except for first three hanger points of each water pipe connected to vibration isolated chiller and pumps. Type G isolators shall be installed after the pipe is insulated.
- E. Type H Hanger Isolators: Provide on all suspended piping for first three hanger points of each water pipe connected to vibration isolated chillers and pumps.
- F. Type S Hoses: Provide at compressed air piping connection to air compressor. Provide on refrigerant piping connected to compressors and condensing units.
- G. Type T Hoses: Provide on suction and discharge piping connection to vibration isolated floor-mounted pumps.
- H. The installation of vibration isolators shall not cause any change of position of piping, that will result in stresses in piping connections or misalignment of shafts or bearings. Account for changes in height and weight when pipes are filled with water.

- I. Resilient Penetration Sleeve/Seals: Provide penetration seals to maintain an airtight seal around penetrating elements and to prevent rigid contact of penetrating element and building construction. Fit sleeve tightly to building construction and seal airtight on both sides of construction penetrated with acoustic sealant.

3.4 DUCT ISOLATION

- A. Support ductwork and suspended plenums rated 6-inch w.g. or above with Type I hanger isolators within 50 feet of air handling units, fans and mechanical equipment rooms.

3.5 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. 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.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR MECHANICAL PIPING, DUCTWORK, AND EQUIPMNET

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Identification labels, warning signs, and nameplates for piping, ductwork, and equipment; valve tags; and wire markers.
- B. Identification and labeling requirements for control panels, instrumentation, including control valves and dampers, control instruments, panel instruments, wire, cable and tubing, shall be per specification sections 25 00 00 50, "Identification".

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 20 00 - Building Services Piping
- D. Section 23 21 16 - Hydronic Piping Specialties
- E. Section 23 21 23 - Hydronic Pumps
- F. Section 23 22 16 Steam and Condensate Heating Piping Specialties
- G. Section 23 25 00 - Water Treatment Systems
- H. Section 23 25 33 - HVAC Water Filtration Equipment
- I. Section 23 31 13 – Ducts and Duct Accessories
- J. Section 23 34 16 - Fans
- K. Section 23 57 00 – Heat Exchangers
- L. Section 23 64 16 – Liquid Water Chillers
- M. Section 23 65 13 – Packaged Cooling Towers
- N. Section 23 73 13 - Indoor Basic Air Handling Units
- O. Section 23 73 16 – Air Rotation Units
- P. Section 23 73 43 – Outdoor Custom Air Handling Units
- Q. Section 23 81 26 – Split System Air Conditioners

- R. Section 23 82 39 - Unit Heaters
- S. Section 25 00 00 – Chiller Plant Control System
- T. Section 25 00 10 - Hot Water Skid Control system
- U. Section 25 00 20 – Air Handlers Control System

1.3 QUALITY ASSURANCE

- A. All work, materials, equipment, installation and accessories shall comply with the International Mechanical Code and all District, and federal regulations.
- B. Comply with requirements of the following:
 - 1. ASME A13.1, Scheme for the Identification of Piping Systems.
 - 2. ANSI Z535.1, American National Standard for Safety Colors.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, “Basic Mechanical Materials and Methods”.
- B. Manufacturer's technical product data, including installation instructions, accessories, supports, fittings, finishes, construction details, and dimensions of assemblies and components:
 - 1. Labels
 - 2. Warning Signs
 - 3. Nameplates
 - 4. Valve Tags
 - 5. Wire Markers

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced and shall be the latest adopted date of the publication. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials and perform all labor required for a complete identification system as indicated on the drawings and as specified.

PART 2 PRODUCTS

2.1 EQUIPMENT NAMEPLATES

A. Metal Nameplates for Equipment:

1. Material and Thickness: Brass, 0.032-inch; stainless steel, 0.025-inch; aluminum, 0.032-inch; or anodized aluminum, 0.032-inch; minimum thickness metal plates, with predrilled or stamped holes for attachment hardware.
2. Minimum Nameplate Size: Length and width vary for required nameplate content, but not less than 2-1/2-by-3/4-inch.
3. Minimum Letter Size: 1/2-inch-high block type, with capital white letters on a black background for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
4. Provide 1/2-inch-high white letters on a red background for emergency operating instructions for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Plastic Nameplates for Equipment:

1. Material and Thickness: Multilayer, laminated, multicolor, phenolic plates with beveled edges for mechanical engraving, 1/8 inch, with predrilled holes for attachment hardware.
2. Maximum Temperature: Able to withstand temperatures of up to 160 degrees F.
3. Minimum Nameplate Size: Length and width vary for required nameplate content, but not less than 2-1/2-by-3/4-inch.
4. Minimum Letter Size: Engraved 1/2-inch-high block type, with capital white letters on a black background for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - a. Provide engraved 1/2-inch-high white letters on red background for emergency operating instructions for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

C. Fasteners: Stainless steel rivets or self-tapping screws.

D. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

E. Nameplate Content: Include equipment's Drawing designation or unique equipment number.

F. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.2 WARNING SIGNS AND WARNING LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, with predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures of up to 160 degrees F.
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4-inch.

- D. Minimum Letter Size: 1/2-inch for name of units for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- E. Fasteners: Stainless steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- H. Label Content: Include caution and warning information plus emergency notification instructions.
- I. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Seton.

2.3 PIPE LABELS

- A. Preprinted, color coded pipe labels, with lettering indicating service and showing flow direction in accordance with ASME A13.1 and ANSI Z535.1.
- B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service. Also include:
 - 1. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
 - 2. Lettering Size: Size letters in accordance with ASME A13.1 for piping, however; not less than 1-inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.
- E. Manufacturer: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.4 DUCT LABELS

- A. Preprinted, color coded duct labels, with lettering indicating service and showing flow direction in accordance with ASME A13.1 and ANSI Z535.1.
- B. Duct Labels: Semirigid plastic formed to attach to duct with fasteners or adhesive.
- C. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Duct Label Contents: Include identification of ductwork service. Also include:
 - 1. Flow-Direction Arrows: Include flow-direction arrows on distribution ductwork. Arrows may be either integral with label or applied separately.
 - 2. Lettering Size: Size letters in accordance with ASME A13.1 for piping, however; not less than

1-inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

- E. Manufacturer: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.5 VALVE, REGULATOR, AND CONTROL TAGS

- A. Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers filled with black paint.
1. Tag Material: Solid, Polished Brass, 0.04-inch minimum thickness or Aluminum, 0.031-inch minimum thickness, as applicable, with predrilled or stamped holes for attachment hardware.
 2. Tag Size: 1-1/2-inch diameter.
 3. Fasteners: Brass S-hook or Aluminum S-hook, as applicable.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Include valve-tag schedule in operation and maintenance data.
- C. Manufacturers: Brady, Brimar Industries, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.6 WARNING TAGS

- A. Preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4-by-7 inches.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption, such as "DANGER," "CAUTION," or "DO NOT OPERATE."
- B. Manufacturers: Brady, Craftmark Pipe Markers, Kolbi Pipe Markers, Seton.

2.7 WIRE MARKERS

- A. Requirements shall be per specification 25 00 00 50, "Identification"

PART 3 EXECUTION

3.1 PREPARATION

- A. Clean piping, ductwork, and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.
- E. Protect finished identification to ensure that markings are clear and legible when project is turned over to the Government.

3.3 INSTALLATION OF EQUIPMENT NAMEPLATES, WARNING SIGNS, AND WARNING LABELS

- A. Permanently fasten nameplates, signs, and labels on each item of mechanical equipment.
- B. Warning Sign and Label Colors.
 - 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.
- D. Designate which items are main or standby.
- E. Equipment requiring identification:
 - 1. Air Cooled Condensing Units
 - 2. Air Handling Units
 - 3. Air Rotation Units
 - 4. Air Separators
 - 5. Blower Coils
 - 6. Bypass Water Filters
 - 7. Chemical Treatment System
 - 8. Chillers
 - 9. Compressors
 - 10. Control Panels
 - 11. Heat Exchangers
 - 12. Cooling Towers
 - 13. Duct Smoke Detectors
 - 14. Expansion Tanks
 - 15. Fans
 - 16. Filters
 - 17. Flow Meters
 - 18. Heat Exchangers
 - 19. Humidifiers
 - 20. Pumps
 - 21. Solids Separators
 - 22. Unit Heaters
 - 23. Variable Frequency Motor Controller

24. Ventilators

- F. Electrical Items: Identify disconnect switches, starting devices, controls, control switches, pushbutton stations with nameplates.
- G. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. On each type of service.
 - 2. Mains and principal branches of piping.
 - 3. Within 3 feet of each valve and control device.
 - 4. Near each branch connection, excluding short take-offs.
 - 5. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 6. Within 3 feet of equipment items and other points of origination and termination.
 - 7. Spaced at maximum intervals of 25 feet along each run with a minimum of one marking per room. Reduce intervals to 10 feet in areas of congested piping, ductwork, and equipment.
 - 8. At each side of penetration of walls, partitions and floors within one foot of penetration.
- C. Do not apply pipe labels or tapes directly to bare pipes conveying fluids at temperatures of 125 degrees F (or higher). Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Wrap the circumference of pipe, overlapping both ends of each marker to give 360-degree identification.
- E. Flow Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- F. Pipe-Label Color Schedule:

PIPING SERVICE	TEXT/BACKGROUND COLOR
Lb. Steam	Black/Yellow (Note 1)
Lb. Steam Condensate Return	Black/Yellow (Note 1)
Chemical Feed	Black/Orange (Note 1)
Chilled Water Return	White/Green (Note 1)
Chilled Water Supply	White/Green (Note 1)
Condenser Water Return	White/Green (Note 1)
Condenser Water Supply	White/Green (Note 1)
Electric Traced	Black/Orange
Equalizer Line	White/Green (Note 1)
Heating Water Return	White/Green (Note 1)

PIPING SERVICE	TEXT/BACKGROUND COLOR
Heating Water Supply	White/Green (Note 1)
Overflow Drain	White/Green
Refrigerant Liquid	White/Blue (Note 1)
Refrigerant Relief Vent	White/Blue (Note: 1)
Refrigerant Suction	White/Blue (Note 1)
Vapor Vent	Black/Yellow (Note 1)

Note 1: Provide Safety color for background to comply with ANSI Z535.1.

3.5 INSTALLATION OF DUCT LABELS

- A. Install self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.

1. Provide labels in the following color codes:

DUCTWORK SERVICE	TEXT/BACKGROUND COLOR
Room Exhaust	Black/Yellow
Hood Exhaust	Black/Yellow
General Exhaust	Black/Yellow
Outdoor Air	White/Blue
Primary Supply Air, AHU	White/Green
Return Air, AHU	White/Green
Relief Air	White/Blue
Toilet Exhaust	Black/Yellow

- B. Duct-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

- On each type of service.
- Mains and principal branches of ductwork.
- Within 3 feet of each control device.
- Near each branch connection, excluding short take-offs.
- At access doors, manholes, and similar access points that permit view of concealed ductwork.
- Within 3 feet of equipment items and other points of origination and termination.
- Near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 feet where exposed or are concealed by removable ceiling system with a minimum of one marking per room. Reduce intervals to 10 feet in areas of congested piping, ductwork, and equipment.
- At each side of penetration of walls, partitions and floors within one foot of penetration.

- C. Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

- Identify as to nature, services, system number or other designation by stenciling with letters 1-inch high and colored to contrast with background. Black letters on White background.
- Identify the device within ductwork access doors to fire dampers, smoke dampers, and smoke detectors, using letters not less than 1/2-inch in height.

3.6 INSTALLATION OF VALVE, REGULATOR, AND CONTROL TAGS

- A. Install tags on valves, regulators, controls, dampers and similar devices in piping and ductwork systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, HVAC terminal devices and similar roughing-in connections of end-use equipment and units.
 - 1. Valves adjacent to equipment they serve need not be tagged.
- B. Valve-Tag Application: Tag valves according to size, shape, and service.
- C. Charts, Diagrams
 - 1. Provide charts or diagrams of size and type as approved to enable quick identification, designating number, service or function, and location of each valve.
 - 2. Include normal operating position (open, closed, or modulating).
 - 3. Include outline plan of building indicating location and number of each riser, with its control valve.
 - 4. Frame charts, and diagrams in approved wood or metal frames with clear glass front, secure to walls in location as directed.
 - 5. Bind one copy of this information in the Operating and Maintenance Manual.

3.7 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where applicable.

3.8 WIRE MARKERS

- A. Identify control wires with wire markers.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Preparation, testing, adjusting, and balancing of mechanical equipment, water distribution and air distribution systems including inspection and certification reports.

1.2 RELATED DIVISIONS

- A. Division 01 - General Requirements
- B. Division 22 - Plumbing
- C. Division 23 - Heating, Ventilating, and Air Conditioning
- D. Division 25 - Integrated Automation
- E. Division 26 - Electrical
- F. Division 28 - Electronic Safety and Security

1.3 QUALITY ASSURANCE

- A. Agency shall be a member of the Associated Air Balance Council. Acceptable Agencies: American Testing, Inc., Baumgartner, Inc., Testing and Balancing, Inc.
- B. Perform work in accordance with AABC National Standards.
- C. Certify that measurement instruments have been calibrated within 12 months prior to use on this project.
- D. Agency shall directly oversee work performed by it employing a competent supervisor subject to the approval of the Contracting Officer's Representative (COR).

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00 "Basic Mechanical Materials and Methods".
- B. Qualifications of Personnel
- C. List of Instrumentation and Instrumentation Certification Report
- D. Proposed Work Schedule Outline

- E. Equipment Installation Inspection Report(s)
- F. Testing, Adjusting and Balancing Report

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Obtain applicable contract documents and copies of submittals for equipment and automatic control systems.
- B. After cleaning, prepare systems for proper operation. Systems shall be completely installed and in continuous operation before testing, adjusting and balancing (TAB) work is performed.

PART 2 PRODUCTS

2.1 DUCTWORK TEST HOLE PLUGS

- A. Removable self-sealing plastic

2.2 INSULATION REPAIR

- A. Match original material type, vapor barrier jacket and thickness.

PART 3 EXECUTION

3.1 DUCTWORK TEST HOLE PLUGS

- A. Install plugs in ductwork after drilling test holes.

3.2 INSULATION REPAIR

- A. Repair insulation removed or damaged for TAB work.

3.3 INDEPENDENT TAB AGENCY

- A. Procure the services of an independent balancing and testing agency to perform the testing, adjustment and balancing (TAB) of equipment and air and water flows including plumbing system; air outlets in the heating, ventilating and air conditioning systems. Report instances in which the specified quantities cannot be provided by the installed equipment so that corrections to the

equipment can be made under the section wherein it was specified.

- B. Add dampers and valves required for correct balance as recommended by the agency at no additional cost to Government. Submit such additions for COR's review.

3.4 TAB INSTRUMENTS

- A. Calibrate instruments used for testing and balancing of air and hydronic systems within a period of 12 months prior to TAB. Submit final test analysis reports, including a letter of certification listing instrumentation used and last date of calibration.

3.5 TAB REPORTS

- A. Inspection reports covering equipment and systems installation shall be submitted during early stage of the project in order to allow timely correction of deficiencies.
- B. Follow check list format developed by AABC, supplemented by narrative comments, with emphasis on air handling units and fans. Check for conformance with submittals. Verify that diffuser, register, and grille sizes are correct. Check installation including insulated flexible duct sizes and routing.
- C. TAB reports covering flow balance, adjustments, and performance tests, working copy of reports shall be submitted as soon as TAB is performed for any necessary system evaluation.
- D. Include in final reports uncorrected installation deficiencies noted during TAB and applicable explanatory comments on test results that differ from design requirements.
- E. Submit three copies of complete test reports for review.

3.6 TAB PHASING

- A. Coordinate TAB procedures with phase construction completion requirements for the project. Systems serving completed phases of the project will require TAB for such phases prior to partial acceptance and for final acceptance.
- B. Allow sufficient time in construction schedule for TAB and submission of reports prior to partial acceptance and for final acceptance.

3.7 EQUIPMENT INSTALLATION INSPECTION

- A. An evaluation report shall be completed after air distribution equipment is on site and duct installation has begun, but in advance of performance testing and balancing work. Identify and report deviations from design and ensure that systems will be ready for TAB at the appropriate time.

3.8 TAB REQUIREMENTS

- A. Provide TAB for equipment and motors including performance tests as required in applicable sections of Divisions 22, 23 and 25.
- B. During final TAB, related systems shall be in full operation.
- C. Test and balance systems in all specified modes of operation. Verify that dampers and other controls function properly.
- D. Balance primary-secondary (variable flow) systems at design flow and verify that variable flow controls function properly.
- E. Operate fans at slowest speed that will deliver indicated air quantity.
- F. Compensate for condition of air and water filters at time of balancing so that system will deliver proper amount of air or water, respectively when filters become dirt-laden and nearly due for replacement.
- G. Record positions of outdoor, return, and relief dampers as set for cooling cycle; and bypass dampers.
- H. Adjust duct volume dampers to minimize outlet and inlet damper throttling.
- I. Install sectorizing baffles in diffusers to overcome drafts caused by flow interference of obstructions.
- J. Operating Tests: Demonstrate to COR the specified performance of systems and components.

3.9 RENOVATION WORK REQUIREMENTS

- A. Prior to start of construction, obtain GPM flow in hot and chilled water system for renovated area. Information obtained shall be provided to COR when reading is obtained.
- B. Prior to start of construction, obtain airflow quantity in supply return exhaust systems for renovated area. Information obtained shall be provided to COR when reading is obtained.

3.10 ROOM PRESSURIZATION VERIFICATION

- A. By smoke test at doorways, verify supply and exhaust air imbalance for the following spaces:
 - 1. Press Room- POSITIVE PRESSURE (OUTWARD FLOW) as indicated on drawings.
 - 2. Clean Room - POSITIVE PRESSURE (OUTWARD FLOW) as indicated on drawings.
 - 3. Office/Breakrooms - NEUTRAL PRESSURE as indicated on drawings.
- B. In addition to the smoke test, verify supply and exhaust air imbalance with differential pressure reading. Record pressure with door open and with door closed. Differential shall not be less than 0.001-inch water gauge with door closed.

3.11 COORDINATION WITH THE AUTOMATIC CONTROL SUBCONTRACTOR

- A. The Automatic Control System (ACS) Subcontractor shall put the system in the required mode of operation as requested by the Testing and Balancing (TAB) Subcontractor. All programming changes and reporting of data from the Building Automation System (BAS) needed to achieve proper performance shall be done by the ACS Subcontractor. The TAB Subcontractor shall be the lead Subcontractor in coordinating his work and the ACS Subcontractor's work. All work is by the TAB Subcontractor unless noted as being the responsibility of the ACS Subcontractor.

END OF SECTION 23 05 93

SECTION 23 07 00 - HVAC INSULATION

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Insulation for piping, ductwork, and equipment (that is not factory insulated) specified in Division 23.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 08 16 - Commissioning of HVAC System
- D. Section 23 20 00 - Building Services Piping
- E. Section 23 21 16 – Hydronic Piping Specialties
- F. Section 23 21 23 – Hydronic Pumps
- G. Section 23 22 16 – Steam and Condensate Heating Piping Specialties
- H. Section 23 25 33 – HVAC Water Filtration Equipment
- I. Section 23 31 13 – Ducts & Duct Accessories
- J. Section 23 57 00 – Heat Exchangers
- K. Section 23 64 16 – Liquid Water Chillers

1.3 QUALITY ASSURANCE

- A. Unless otherwise noted, pipe insulation shall have a K value insulation conductivity Btu inch/hour-ft² degrees F in accordance with IECC 2018.
- B. Unless otherwise noted, duct insulation shall have an insulation R-value (hour)(ft²) (degrees F)/Btu in accordance with IECC 2018.
- C. Duct insulation materials are restricted to those which are UL listed in accordance with the requirements of NFPA 90A, latest edition, and with a flame spread index not over 25 and a smoke developed index no higher than 50.
- D. Insulation on pipes and ducts through floors, fire rated walls, and smoke barriers shall be UL listed fire-stop insulation to maintain fire resistance of the floor, fire rated wall, or smoke barrier in accordance with NFPA 101.

- E. Field applied canvas, woven glass fiber reinforcing mesh, woven polyester mesh, and woven glass fiber cloth coverings shall be flame and mildew proof.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Each type of insulation: Manufacturer and product designation, surface burning characteristics, thickness, density in pounds in accordance with cubic foot, thermal conductivity or R-value, water-vapor permeance thickness, jackets (factory and field applied), and accessories.
- C. System application for each type of insulation.
- D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail application at linkages of control devices.
 - 3. Detail attachment and covering of heat tracing inside insulation.
 - 4. Detail removable insulation at piping specialties.
 - 5. Detail removable insulation at equipment connections.
 - 6. Detail insulation application of pipe expansion joints for each type of insulation.

1.5 INFORMATIONAL SUBMITTALS

- A. Statement of compliance with IECC 2018.
- B. Statement of compliance with NFPA 90A, flame spread index and smoke developed index requirements.
- C. Statement of compliance with National Architectural and Industrial Maintenance Rule for VOC levels on Adhesives, Mastics, and Coatings for the District of Columbia and any Federal/local regulations.
- D. Statement of compliance with Ozone Transport Commission for VOC levels on Adhesives, Mastics, and Coatings for the District of Columbia and any Federal/local regulations.

1.6 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Where insulation must be stored outdoors, provide polyethylene film cover for protection. Insulation that becomes wet shall be replaced; drying of insulation is not acceptable.

- B. Coordinate sizes and locations of supports, hangers and insulation shields specified in other sections of the specifications.
- C. Coordinate clearance requirements for installation of insulation and field-applied jackets and finishes for pipe, ductwork, and equipment installation and space for maintenance.
- D. Coordinate with installation and testing of heat tracing.

PART 2 PRODUCTS

2.1 GENERAL MATERIAL REQUIREMENTS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Products shall comply with the National Architectural and Industrial Maintenance (AIM) Rule for VOC levels for the District of Columbia and any Federal/local regulations.
- C. Products shall comply with the Ozone Transport Commission limits for VOC levels for the District of Columbia and any Federal/local regulations.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

2.2 ADHESIVES, MASTICS, COATINGS

A. Adhesives:

1. Type A1:

- a. High tack, rapid setting water-based adhesive.
- b. Solvent free, low VOC (0.03 pounds/gallon) synthetic elastomer emulsion.
- c. Non-flammable when wet and fire-resistive when dry.
- d. Moisture resistant.
- e. Flame spread index 0 and smoke developed index 0.
- f. Asbestos, lead, and mercury free.
- g. ASTM C916 Type II.

B. Mastics:

1. Type M1:

- a. White, flexible, water-based vapor barrier mastic.
- b. Low VOC (0.3 pounds/gallon).
- c. Non-flammable when wet and fire-resistive when dry.
- d. Water resistant and low water vapor permeance.
- e. Flame spread index 5 and smoke developed index 25.
- f. Asbestos, lead, and mercury free.
- g. MIL-C-19565C, Type II.

2. Type M3:

- a. White, flexible, elastomeric coating.
- b. Vapor barrier for outdoor application, chemical resistant, and UV and sunlight resistance.
- c. Fire resistant.
- d. Flame spread index 10 and smoke developed index 15.
- e. Asbestos, lead, and mercury free.

C. Coatings:

1. Type C1:

- a. White, washable, abrasion-resistant coating.
- b. Low VOC (0.13 pounds/gallon).
- c. Fire resistant.
- d. Flame spread index 10 and smoke developed index 5.
- e. Asbestos, lead, and mercury free.
- f. MIL-A-3316C, Class I, Grade A.

D. Manufacturers: Childers, Foster, Mon-Eco Industries.

2.3 INSULATION TYPES

A. Type A:

- 1. Insulation: Pre-formed, sectional molded glass fiber pipe insulation bonded with a thermosetting resin meeting ASTM C547 Standard Specifications for Mineral Fiber Pipe Insulation, Type I, Grade A.
- 2. Minimum Density: 3.0 pounds per cubic foot.
- 3. Factory Applied Jacket: White, polypropylene-coated ASJ jacket with self-sealing, pressure sensitive, acrylic based adhesive covered by a removable protective strip, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
- 4. Factory-fabricated shapes in accordance with ASTM C450 and ASTM C585.
- 5. Insulated Fitting Covers: Insulation insert with PVC cover equivalent to Zeston.
- 6. Operating Temperatures: 0 to 850 degrees F.
- 7. Maximum Moisture Vapor Transmission: 0.01 perms.
- 8. Manufacturers: Johns-Manville Micro-Lok HP Ultra, Knauf Earthwool 1000o Pipe Insulation, Owens-Corning Fiberglass Insulation SSLII with ASJ Max.
- 9. Polyguard RG-CW or approved equal mineralization coating for application to the interior surface of the insulation.

B. Type B:

- 1. Insulation: Non-combustible, inorganic, asbestos free, hydrous calcium silicate meeting ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation, Type I.
- 2. Minimum density: 10 pounds per cubic foot.
- 3. Field Applied Jacket: Comply with MIL-C-20079H, Type I, plain weave, minimum 8-ounce/square yard) woven glass fiber fabric.
- 4. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions

- used in preforming insulation to cover valves, tees, and flanges.
5. Manufacturers: Industrial Insulation Group, Johns-Manville.

C. Type C:

1. Insulation: Flexible, closed-cell elastomeric pipe insulation equal to AP Armaflex or ArmaFlex Ultra (for air plenums), meeting ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Type I.
2. Minimum Density: 5 pounds cubic foot.
3. Material shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as tested by ASTM E84.
4. Where applicable, insulation Materials shall be listed and labeled per UL723 in plenum spaces, as required by Code.
5. Operating Temperatures: Minus 70 to 220 degrees F.
6. Maximum Moisture Vapor Transmission: 0.08 perms.
7. Manufacturers: Aeroflex, Armacell, K-flex.

D. Type D:

1. Insulation: Flexible, unfaced glass fiber blanket bonded with a thermosetting resin meeting ASTM C665 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing, Type I.
2. Minimum Density: 3/4 pound per cubic foot.
3. Maximum Operating Temperature: 450 degrees F.
4. Manufacturers: Johns-Manville Formaldehyde-Free Fiberglass Insulation, Knauf EcoRoll Insulation, Owens-Corning RA Series EcoTouch.

E. Type E:

1. Insulation: Flexible glass fiber blanket bonded with a thermosetting resin meeting ASTM C553 Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications, Type II.
2. Minimum Density: 3/4-pound per cubic foot.
3. Factory Applied Jacket: FRK/FSK facing, vapor retardant barrier jacket of minimum 0.001-inch aluminum foil, fiberglass reinforced scrim with kraft paper backing, complying with ASTM C1136, Type II.
4. Operating Temperatures:
 - a. Glass Fiber: Up to 250 degrees F.
5. Maximum Moisture Vapor Transmission: 0.02 perms.
6. Manufacturers: Certain-Teed, Johns-Manville Microlite EQ FSK Duct Wrap, Knauf Atmosphere Duct Wrap, Owens-Corning SoftR Duct Wrap FRK.

F. Type F:

1. Insulation: Semi-rigid, glass fiberboard bonded with a thermosetting resin meeting ASTM C1393 Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks, Type II or IIIA, Category 2.
2. Minimum Density: 2.5 pounds per cubic foot:
 - a. Up to and Including 22-inch Diameter: Sectional molded type.

- b. Twenty-four-inch Diameter and Above: Sectional molded type or rigid board accurately beveled or scored.
 - 3. Factory Applied Jacket: White, polypropylene coated ASJ jacket, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
 - 4. Operating Temperatures: 35 to 850 degrees F.
 - 5. Maximum Moisture Vapor Transmission: 0.02 perms.
 - 6. Manufacturers: Certain-Teed CrimpWrap Pipe & Tank, Johns-Manville Micro-Flex, Knauf KwikFlex, Owens-Corning Flex Wrap ASJ.
- G. Type G:
- 1. Insulation: Rigid glass fiberboard bonded with a thermosetting resin meeting ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation, Type IA or IB.
 - 2. Minimum Density: 6.0 pounds per cubic foot.
 - 3. Factory Applied Jacket: White, polypropylene-coated ASJ jacket, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
 - 4. Operating Temperatures: 35 to 250 degrees F.
 - 5. Maximum Moisture Vapor Transmission: 0.02 perms.
 - 6. Corner Angles: PVC, Aluminum, or Stainless Steel suitable for the application.
 - 7. Manufacturers: Certain-Teed Commercial Board, Johns-Manville 800 Series Spin-Glas, Knauf Earthwool Insulation Board, Owens-Corning 700 Series Board Insulation.
- H. Type H:
- 1. Insulation: Rigid glass fiberboard bonded with a thermosetting resin meeting ASTM C612 Standard Specification for Mineral Fiber Block and Board Thermal Insulation, Type IA or IB.
 - 2. Minimum Density: 6.0 pounds per cubic foot.
 - 3. Factory Applied Jacket: White, polypropylene-coated ASJ jacket, kraft paper, fiberglass reinforced scrim with aluminum foil backing, complying with ASTM C1136, Type I.
 - 4. Operating Temperatures: 35 to 250 degrees F.
 - 5. Maximum Moisture Vapor Transmission: 0.02 perms.
 - 6. Corner Angles: PVC, Aluminum, or Stainless Steel suitable for the application.
 - 7. Manufacturers: Certain-Teed CertaPro Commercial Board, Johns-Manville 800 Series Spin-Glas, Knauf Earthwool Insulation Board, Owens-Corning 700 Series Board Fiberglass Insulation.
- I. Type K:
- 1. Insulation: Flexible, closed-cell elastomeric sheet insulation equal to AP Armaflex or ArmaFlex Ultra (for air plenums) meeting ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Type II.
 - 2. Minimum Density: 3 to 5 pounds per cubic foot.
 - 3. Material shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as tested by ASTM E84.
 - 4. Where applicable, insulation Materials shall be listed and labeled per UL723 in plenum spaces, as required by Code.
 - 5. Operating Temperatures: Minus 70 to 220 degrees F.
 - 6. Maximum Moisture Vapor Transmission: 0.08 perms.
 - 7. Manufacturers: Aeroflex, Armacell, K-flex.
- J. Type L:

1. Insulation: Flexible, closed-cell elastomeric sheet insulation equal to AP Armaflex meeting ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Type II.
2. Minimum Density: 5.0 pounds per cubic foot.
3. Material shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as tested by ASTM E84.
4. Where applicable, insulation Materials shall be listed and labeled per UL723 in plenum spaces, as required by Code.
5. Operating Temperatures: Minus 70 to 220 degrees F.
6. Maximum Moisture Vapor Transmission 0.08 perms.
7. Enclosure: 18-gage galvanized steel.
8. Manufacturers: Aeroflex, Armacell, K-flex.

K. Type N:

1. Insulation: Non-combustible, inorganic, asbestos-free, molded block or board hydrous calcium silicate meeting ASTM C533 Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation, Type I.
2. Minimum density: 10 pounds per cubic foot.
3. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, tees, and flanges.
4. Manufacturers: Industrial Insulation Group, Johns-Manville.

L. Type O:

1. Insulation: Flexible, closed-cell elastomeric sheet insulation laminated with white thermoplastic rubber (TPR) membrane, equal to ArmaTuff or ArmaTuff SA meeting ASTM C534 Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form, Type II.
2. Maximum Moisture Vapor Transmission: 0.02 perms (1.2 ng/Pa.s.m2).
3. Material shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as tested by ASTM E84
4. Operating Temperatures: Minus 70 to 220 degrees F (minus 57 to 104 degrees C).
5. Tape: ArmaTuff tape for protection of seams and exposed edges.
6. Manufacturers: Aeroflex, Armacell, K-flex.

M. Type P:

1. Insulation: Inorganic, incombustible cellular glass insulation with annealed, rigid, hermetically sealed cells, meeting ASTM C552 Standard Specification for Cellular Glass Thermal Insulation, equal to Owens-Corning FOAMGLAS insulation.
2. Provide Type II, Class 2 for chilled water applications.
3. Minimum Density: 6.1 pounds per cubic foot.
4. Cellular glass pipe insulation shall be fabricated according to the requirements of ASTM C1639 Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation.
5. Factory fabricated shapes in accordance with ASTM C450 and ASTM C585.
6. Factory Applied Jacket:
 - a. For indoor applications, non-cellulose multi-ply laminated fiberglass-reinforced polypropylene, PVC or vinyl faced/metalized firm backed jacket. Jacket must not contain known mold or mildew nutrients, and exhibit no mold growth when tested according to ASTM C1338 "Determining Fungi Resistance of Insulation Materials and

Facings" equal to 7-mil thick PITTWRAP CF jacketing for chilled water service.

- 1) Maximum moisture vapor transmission of 0.07 perms.
- b. For outdoor applications, PITTWRAP IW30 with 0.024-inch aluminum jacketing with 1/2-inch by 0.015-inch bands with matching seals.
7. Weather barrier mastic: PITTCOTE 404 Coating supplied by Owens-Corning.
8. Joint Sealant:
 - a. High performance, MS Polymer based sealant used for sealing joints in FOAMGLAS insulation systems on chilled water applications, equal to PITTSEAL CW sealant by Owens-Corning.
 - b. Silicone adhesive used for sealing joints in FOAMGLAS insulation systems on steam and steam condensate applications, equal to PC HiTemp RTV sealant by Owens-Corning.
9. Bore Coating:
 - a. Chilled Water: PITTCOTE 16LTAA by Owens-Corning.
10. Tape shall be 3/4-inch-wide fiber reinforced tape such as Scotch #880 or equal.
11. Manufacturers: Owens-Corning.

2.4 TAPES:

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136:
 1. Width: 3 inches.
 2. Thickness: 10.8 mils.
 3. Adhesion: 45 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
 7. Manufacturers: Ideal Tape Co., Johns-Manville, Knauf, Owens-Corning, 3M, Venture Tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136:
 1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 45 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
 7. Manufacturers: Ideal Tape Co., Knauf, Owens-Corning, 3M, Venture Tape.
- C. PVDC Tape for Outdoor Applications: White biaxially oriented barrier film, vapor-retarder PVDC tape with acrylic adhesive:

1. Width: 3 inches.
2. Film Thickness: 6 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.
6. Manufacturers: Extol, Johns-Manville, Polyguard, Zeston.

2.5 FIELD APPLIED PIPE JACKETS

A. PVC Jacket:

1. High-impact resistant, UV-resistant PVC complying with ASTM D 1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) compounds and Chlorinated Polyvinyl Chloride (CPVC) compounds. and Class 16354-C; 30 mils thick, roll stock ready for shop or field cutting and forming.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White Color-coded jackets based on system.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
5. Manufacturers: Johns Manville; P.I.C. Plastics, Inc.; Proto Corporation; Speedline Corporation.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications:

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.
6. Manufacturers: ABI, Compac Corporation, Venture Tape.

C. PVC Jacket Adhesive: Compatible with PVC jacket:

1. Indoor Applications: Adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Manufacturers: Dow Corning Corporation 739, Dow Silicone; Johns Manville Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive; P.I.C. Plastics, Inc. Welding Adhesive; Speedline Corporation Polyco VP Adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application:

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

- A. Clean and dry surfaces to receive insulation of loose scale, dirt, oil, water, and other foreign materials that will adversely affect insulation application.
- B. Complete piping, ductwork, and equipment tests before insulation is applied.
- C. Coordinate insulation installation with the tradesman installing heat tracing. Do not apply insulation until heat tracing has been tested. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water. If insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL PREPARATION AND APPLICATION REQUIREMENTS

- A. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system, duct system, and equipment, as specified in insulation system schedules.
- B. Insulate completely metal surfaces of piping, ductwork, and equipment other than hangers as delineated under Extent of Insulation.
- C. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- D. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- E. Install insulation with least number of joints practical.
- F. Permit expansion and contraction without causing damage to insulation or surface finish.
- G. Extend surface finish to protect surfaces, ends, and raw edges of insulation.
- H. Fire-stop insulation shall be continuous to 6 inches on either side of barrier. Seal jacket seam and end joints to adjacent sections of insulation for continuous vapor barrier. Annular space between insulation and sleeve shall be sealed as specified in Section 23 05 00, "Basic Mechanical Materials and Methods," in the Article titled, "Sleeves and Escutcheon Plates."
- I. Provide vapor retarding barriers continuous and uninterrupted throughout the system where specified, except where insulation is interrupted for fire dampers, and duct heaters.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with water-based vapor-barrier mastic:
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor

- legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with water-based vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Where connections are made to existing systems, provide insulation as specified and to match existing where existing insulation is removed or damaged for new connection. Provide vapor barrier continuously sealed to the existing insulation.
- L. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- M. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- N. Install multiple layers of insulation with longitudinal and end seams staggered.
- O. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- P. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that become wet.
- Q. Cut insulation in a manner to avoid compressing insulation.
- R. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- S. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- T. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.
 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches on center.
 4. For below ambient services, apply vapor-barrier mastic over staples.
 5. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 6. Where vapor barriers are indicated, apply vapor barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- U. Coordinate insulation installation with installation of heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.4 PENETRATIONS

- A. Roof and Aboveground Exterior Wall Penetrations: Install insulation continuously through penetrations:
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface for roof penetrations, and at inside wall surface for wall penetrations. Seal with joint sealant.
 - 3. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 4. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing for roof penetrations, and outside wall flashing for wall penetrations and overlap wall flashing at least 2 inches.
 - 5. Seal jacket to roof flashing and wall flashing with flashing sealant.
- B. Non-Fire Rated Interior Floor, Wall and Partition Penetrations: Install insulation continuously through floors, walls and partitions.
- C. Fire-Rated Floor, Wall and Partition Penetrations:
 - 1. Duct: Terminate insulation at fire damper sleeves and externally insulate damper sleeves to match adjacent insulation. Overlap duct insulation at least 2 inches.
 - 2. Pipe: Install insulation continuously through floor, wall, and partition penetrations.
 - 3. Seal penetrations through fire-rated assemblies according to Section 07 84 13, "Penetration Firestopping."
- D. Vermin Proofing: Wherever insulated piping and ductwork pass through sleeves or openings which are required to be vermin proof, provide sections of foamed glass insulation equal in length to length of sleeves. Refer to Section 23 05 00, "Basic Mechanical Materials and Methods," in the Article titled, "Sleeves and Escutcheon Plates" for details and extent of vermin proofing.

3.5 GENERAL INSULATION INSTALLATION

- A. Piping:
 - 1. Insulate valves, strainers, fittings, unions, mechanical couplings, flanges, and other specialties.
 - 2. Install insulation with continuous thermal and vapor retardant integrity, unless otherwise noted.
 - 3. Use preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe where available. Where preformed material is not available, use sectional pipe insulation.
 - 4. Insulate pipe elbows and butt tightly against adjoining piece and bond with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 5. Insulate tee fittings and butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 6. Insulate valve bodies and flanges up to and including bonnets, valve stuffing-box studs, bolts, and nuts except for chilled and condenser water valves. Insulate over packing nuts in a manner to permit removal for adjustment and repacking of chilled and condenser water valves. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe

- insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement.
7. Insulate strainers in a manner to permit removal of the basket without disturbing the insulation of the strainer. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 8. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels:
 - a. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
 9. Where specified, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.
 10. Fill hollow interior of protection saddles with insulating cement.
 11. Insulate air separator chamber as specified for fittings.
 12. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
 13. Where removable insulation covers are indicated, make insulation form sectional pipe insulation of the same thickness as that of the adjoining pipe. Install same insulation jacket as that of the adjoining pipe insulation

B. Ductwork:

1. Use of materials is restricted for duct insulation to those which are UL listed in accordance with the requirements of NFPA 90A, latest edition, and with a fire hazard rating as tested in accordance with ASTM E84 and UL 723, not to exceed 25 flame spread index and smoke developed index not to exceed 50.
2. Where applicable, insulation Materials shall be listed and labeled per UL723 in plenum spaces, as required by Code.
3. Cover standing seams and metal surfaces with insulation.
4. Provide staples that are stainless steel, outward clinching, and sealed to maintain vapor barrier.
5. Unless otherwise indicated, insulation is not required on:
 - a. On factory insulated flexible ducts or factory insulated plenums and casings
 - b. Flexible connectors
 - c. Vibration control devices
 - d. Factory insulated access panels and doors.
6. Interrupt insulation at fire dampers in walls and floors. Lap and seal vapor barrier over ends of insulation.

C. Equipment:

1. Groove or score insulation to fit shape and contour of equipment. Bevel insulation edges for cylindrical surfaces for tight joints.
2. Stagger end joints. Stagger joints between insulation layers at least 3 inches.
3. Provide permanently fastened angles or plates, where required, to support insulation. Protect exposed corners with secured corner angles.
4. Do not weld anchor pins to ASME labeled pressure vessels.
5. Apply removable insulation segments on access opening and cover plates as separate sections, with insulation cut back for access to bolt heads and other fasteners. Bevel and seal insulation ends around manholes, handholes, and ASME stamps.
6. Do not cover nameplates. Cut back the insulation, bevel, seal, and line edges with 24-gage galvanized steel.
7. Insulate skirts, cradles, legs and other supports of vessels storing materials at 60 degrees F or lower temperature for a distance away from the vessel four times the thickness of the insulating material same as the vessel.

3.6 ADHESIVES, MASTICS, COATINGS

- A. Apply adhesives, mastics, and coatings at the rate of coverage and in a manner recommended by the manufacturer.
- B. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise noted.
- C. Mastics shall comply with MIL-C-19565C, Type II.
- D. Lagging adhesives shall comply with MIL-A-3316C, Class I, Grade A.

3.7 INSULATION TYPES

A. Type A:

1. Application:

- a. Pipe: Fit insulation to pipe, staggering longitudinal joints. Seal longitudinal joint overlaps with 4-inch-wide sealing strips of vapor barrier jacket material applied on circumferential joints with Type A1 adhesive. Seal end joints and protrusions with Type A1 adhesive. Seal with a 1/16-inch-thick coat of Type M1 mastic for cold condenser lines. Seal with a 1/16-inch-thick coat of Type C1 coating for hot lines. Imbed a layer of glass fiber fitting tape in the mastic or coating and after the initial coat has dried, apply an additional 1/16-inch coat of mastic or coating.
- b. Flanges, Fittings, Elbows, Valves, and Pipe Specialties: Apply fabricated or pre-molded insulated fitting covers or insulating cement equal in thickness and density to adjoining pipe insulation. Seal with a 1/16-inch-thick coat of Type M1 mastic for cold and condenser lines. Seal with a 1/16-inch-thick coat of Type C1 coating for hot lines. Imbed a layer of glass fiber fitting tape in the mastic or coating and after the initial coat has dried, apply an additional 1/16-inch coat of mastic or coating:

- 1) Fill voids with mineral fiber blanket insulation.

- 2) Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing insulation.
 2. Surface Finish:
 - a. All piping:
 - 1) Pipe:
 - a) Standard duty, concealed and exposed – no additional finish required.
 - b) Heavy Duty - Apply a tack coat of Type C1 coating over entire surface; imbed a layer of 8-ounce canvas; when dry, apply a second coat of Type C1 coating.
 - 2) Fittings and Valves:
 - a) Standard Duty – no additional finish required.
 - b) Heavy Duty – Apply a finish coat of Type C1 coating after mastic has thoroughly dried.
 - 3) Apply heavy-duty surface finish to pipes, fittings, and valves in the following locations:
 - a) Mechanical Equipment Rooms.
 - b. For piping outdoors:
 - 1) Apply 0.016-inch, type 304, stainless-steel jacket with vapor barrier. Place preformed 2-inch butt strap with sealant over seams and secure with 1/2-inch stainless-steel band and wing seal. Factory-Fabricated Fitting Covers:
 - a) Same material, finish, and thickness as metal jacket.
 - b) Preformed two-piece or gore, 45 and 90 degree, short and long radius elbows.
 - c) Tee covers.
 - d) Flange and union covers.
 - e) End caps.
 - f) Beveled collars.
 - g) Valve covers.
 - h) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 3. Chilled and Condenser Water Piping: Coat inside of insulation with mineralization coating. Apply coating to inside core of insulation simultaneously with the installation of the insulation and rotate onto the pipe.
- B. Type B:
 1. Application:
 - a. Pipe: Fit insulation to pipe, staggering longitudinal joints. Secure longitudinal and end laps of canvas jacket with Type C1 coating.

- b. Fittings and Valves: Fabricate mitered pipe sections to match form of fitting or, on piping 3 inches and smaller, apply one coat of insulating cement to match insulation thickness but not less than 1-inch.
 - 2. Surface Finish:
 - a. Pipe: No additional finish required.
 - b. Fittings and Valves:
 - 1) Concealed: Apply 4-ounce canvas jacket secured with Type C1 coating.
 - 2) Exposed: Apply 6-ounce canvas jacket secured with Type C1 coating.
- C. Type C:
 - 1. Pipe: Slip the insulation over the pipe wherever possible or slit the insulation sections and apply around the pipe. Seal seams and end joints with ArmaFlex 520 adhesive or equivalent to prevent the passage of air to the surface being insulated.
 - 2. Flanges, Fittings, Elbows, Valves and Pipe Specialties: Fabricate segments of insulation, miter joints using preformed pipe insulation and sections of pipe insulation in accordance with manufacturer's instructions or use prefabricated fittings from the manufacturer or recommended third party. Seal with insulation manufacturer's adhesive to prevent the passage of air to the surface being insulated:
 - a. Fill voids with cut sections of insulation same thickness as pipe insulation.
 - b. Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing insulation.
 - 3. Outdoors:
 - a. Apply two coats of WB Armaflex finish, or approved equal, in accordance with manufacturer's instructions and recommendations.
 - b. Locate seams on lower half of the pipe.
 - 4. Chilled and Condenser Water Piping: Coat inside of insulation with mineralization coating. Apply coating to inside core of the insulation simultaneously with the installation of the insulation and rotate onto the pipe.
- D. Type D:
 - 1. Wrap two or more layers as required for thickness specified firmly around pipe bundle.
 - 2. Secure with cord tied on 9-inch centers.
 - 3. Cover insulation with 45 pound per cubic foot roofing felt secured with bands or wire.
 - 4. Option: 0.016-inch aluminum jacket for piping not in trenches.
- E. Type E:
 - 1. Wrap insulation around duct and seal joints in accordance with manufacturer's instructions. Use of adhesive to attach insulation to duct is prohibited.
 - 2. Secure insulation to bottom side of ducts with long sides or diameters exceeding 24 inches with pins welded or adhered on 18-inch centers. Secure pins with speed clip washers.
 - 3. Butt insulation joints with reinforced foil face extending 2 inches beyond the insulation for lagging and seal flaps with Type A1 adhesive.

4. On rectangular and square ducts, install so insulation is not excessively compressed at corners.
5. Use stainless steel staples to assist in securing insulation approximately 6 inches on center with 1/2-inch outward clinching staples. Seal vapor barrier penetration with Type M1 Mastic.

F. Type F:

1. Apply to duct, staggering longitudinal joints to provide a complete and tight fit to the contour of the duct surface on the exterior.
2. Seal longitudinal joint jacket overlaps and 4-inch-wide sealing strips of jacket material applied on circumferential joints with Type A1 adhesive or self-sealing laps.
3. Use stainless steel staples to assist in securing scored board insulation where joint is hidden.

G. Type G:

1. Application:
 - a. Secure insulation with pins welded or adhered to sheet metal on 15-inch centers. Cut side pieces of insulation to lap top and bottom pieces. Apply Type A1 adhesive to entire underside of horizontal metal surfaces. Secure 1-1/2-inch diameter fiber or tin-coated disk to pins.
 - b. Protect outer corners of insulation with 3-by-3-inch aluminum angles or roll-on corner angle.
 - c. Butt insulation joints, seal with 4-inch vapor barrier foil tape or 2-inch laps adhered with Type A1 adhesive. Seal over penetrations and disks with tape or Type M1 mastic.
2. Surface Finish:
 - a. Imbed glass-reinforcing fabric, 20-by-20 mesh (1-1/2-ounce minimum) in tack coat of Type C1 coating (2 gallons in accordance with 100 square foot) lapping joints a minimum of 2 inches.
 - b. Finish when dry with final coat of Type C1 coating (4 gallons in accordance with 100 square foot).

H. Type H:

1. Application:
 - a. Secure insulation with pins welded or adhered to sheet metal on 15-inch centers. Cut side pieces of insulation to lap top and bottom pieces. Apply Type A1 adhesive to entire underside of horizontal metal surfaces. Secure 1-1/2-inch diameter fiber or tin-coated disk to pins.
 - b. Protect outer corners of insulation with 3-by-3-inch aluminum angles or roll-on corner bead.
 - c. Butt insulation joints, seal with 4-inch vapor barrier foil tape or 2-inch laps adhered with Type A1 adhesive. Seal over penetrations and disks with Type M3 mastic.
2. Surface Finish: Apply two 1/16-inch-thick coats of white Type M3 mastic with a glass reinforcing fabric, 20-by-20 mesh (1-1/2-ounce minimum) between coats, lapping joints a minimum of 2 inches to form a weatherproof finish.

I. Type K:

1. Application:
 - a. Secure insulation to equipment with smooth side out using insulation manufacturer's adhesive on both contacting surfaces for Type AP Armaflex or ArmaFlex Ultra where applicable.
 - b. Fill joints with ArmaFlex 520 adhesive or equivalent.
 - c. Apply layers with staggered seams secured with insulation manufacturer's adhesive where necessary to obtain specified thickness.
 2. Surface Finish: Apply two coats of insulation manufacturer's protective finish as recommended by manufacturer.
 3. For outdoor installations, additionally apply corrugated aluminum metal jacket suitable for installation. Install preformed 2-inch butt strap with sealant over seams and secure with stainless steel sheet metal screws or pop rivets and stainless-steel bands. Provide "S" clips on vertical tanks. Provide prefabricated head covers for storage tanks.
- J. Type L:
1. Line enclosure with sheet insulation. Fasten to equipment with bolts and provide lifting handles for removal without damage to insulation or enclosure. Submit details of enclosure design for COR's review before fabrication.
 2. Fill joints with ArmaFlex 520 adhesive or equivalent.
 3. Apply layers with staggered seams secured with adhesive where required to obtain specified thickness.
- K. Type N:
1. Application: Secure insulation to equipment with Type A2 adhesive and 1/2-inch-wide No. 20-gage stainless steel bands on maximum 9-inch centers. Tighten bands without deforming insulation. Stagger joints. Point joints and voids with insulating cement.
 2. Surface Finish: Apply 1-inch mesh galvanized wire netting securely fastened and pulled tight on surfaces. Use corner beads on edges. Apply 1/2-inch thickness insulating cement to provide hard smooth finish.
- L. Type O:
1. Square and Rectangular Ductwork
 - a. Slope top of the ductwork insulation a minimum of 2 degrees angle to prevent "ponding" of water.
 - b. The duct insulation shall be constructed from the bottom up, with the top insulation sized to extend over the side insulation to form a watershed.
 2. Round Ductwork:
 - a. Insulation shall be wrapped not stretched around the duct:
 - 1) On ductwork larger than 12 inches (300 mm) in diameter, the insulation shall be adhered to the duct surface on the lower one third.
 - 2) On ductwork greater than 24 inches (600 mm) in diameter, the insulation shall be completely adhered to the duct surface. Longitudinal seams shall be located on the lower half of any round ductwork.

3. Non-adhesive insulation shall be adhered directly to clean, oil-free surfaces with a full coverage of ArmaFlex 520 adhesive or equivalent. Self-adhering insulation shall be adhered directly to clean, oil-free surfaces.
4. Apply pipe insulation at ambient temperatures of 40 degrees F (4 degrees C) or above.
5. Butt-edge seams shall be installed in accordance with manufacturer's instructions and recommendations.
6. Standing metal duct seams shall be insulated with the same insulation thickness as installed on the duct surface. Seams may be covered using strips of sheet insulation or half sections of tubular pipe insulation with miter-cut ends. Standing seams shall be adhered using ArmaFlex 520 adhesive or equivalent.
7. Insulation seams shall be staggered when applying multiple layers of insulation.

M. Type P:

1. Application:
 - a. Insulation shall be applied to piping with all longitudinal seams, end joints, and protrusions sealed full depth with vapor barrier mastic and joint sealant. All joints shall be tightly filled with no voids. Joint sealer shall not be used to fill voids or cracks.
2. Bore Coating: Coat interior surface of insulation with a 1/16-inch-thick coat of coating.
3. Flanges, Fittings, Elbows, Valves, and Pipe Specialties: Insulate in a manner similar to that for piping using preformed pipe insulation and sections of pipe insulation in accordance with manufacturer's instructions:
 - a. Fill voids with cut sections of insulation same thickness as pipe insulation.
 - b. Arrange insulation on valves to permit access to packing and to allow valve operation without disturbing insulation.

3.8 FIELD APPLIED PIPE JACKETS

- A. Install PVC jackets on exposed insulated piping. Provide with 1-inch overlap at longitudinal seams and end joints for horizontal applications. Seal with manufacturer's recommended adhesive:
 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Install metal jackets on outdoor insulated piping. Provide with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches on center and at end joints.

3.9 INSTALLATION SCHEDULE

A. Piping:

PIPING SYSTEM	MATERIAL TYPE	INSULATION THICKNESS IN INCHES FOR PIPE SIZE				
		Less than 1"	1 to less than 1-1/2"	1-1/2 to less than 4"	4 to less than 8"	8" & Larger

PIPING SYSTEM	MATERIAL TYPE	INSULATION THICKNESS IN INCHES FOR PIPE SIZE				
		Less than 1"	1 to less than 1-1/2"	1-1/2 to less than 4"	4 to less than 8"	8" & Larger
Outdoor Low Temperature Hot Water Heating (200°F or less)	A	2	2	2	2	2
Indoor Low Temperature Hot Water Heating (200°F or less)	A	1-1/2	1-1/2	2	2	2
Indoor Steam, Steam Vapor V Safety Relief Valve Discharge 0 to 14-psi (201-250°F) 15 to 59-psi (251-350°F) 60-psi & above (above 350°F)	A	2-1/2	3	3	3	3-1/2
	A	3	4	4-1/2	4-1/2	4-1/2
	A	4-1/2	5	5	5	5
Indoor Steam Condensate 0 to 14-psi (201-250°F) 15 to 59-psi (251-350°F) 60-psi & above (above 350°F)	A	2-1/2	3	3	3	3-1/2
	A	3	4	4-1/2	4-1/2	4-1/2
	A	4-1/2	5	5	5	5
Electric Heat Traced Piping (Note 6)	A	1	1	1	1	1-1/2
Electric Heat Traced Piping (Insulated as a bundle) Bundle diameter less than 10-inch Bundle diameter 10-inch and larger	D	2-3/4	2-3/4	2-3/4	2-3/4	2-3/4
	F	1	1-1/2	1-1/2	2	2-1/2
Outdoor Chilled Water (40°F and above) (Note 2)	A, P (Note 5)	3	3	3	3	3
Indoor Chilled Water (40°F and above) (Note 2)	A, P (Note 5)	1-1/2	1-1/2	2	2	3
Outdoor Refrigerant Suction and Hot Gas (Note 2)	A	2	2	2	2	2
Indoor Refrigerant Suction; Hot Gas; and Outdoor and Indoor Refrigerant Liquid (Note 2)	A	1	1	1	1	1-1/2
Auxiliary Water on Water Chillers (Note 2)	A	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2
	C (Note 1)	1	1	1	1	1
Outdoor Condenser Water	A	2	2	2	2	2
Indoor Condenser Water	A	1	1	1	1	1-1/2

B. Ductwork and Plenums (Note 3):

FOR SUPPLY AIR SYSTEMS TRANSPORTING AIR AT 48 DEGREES F AND ABOVE	MATERIAL TYPE	INSULATION THICKNESS (INCHES)
Concealed	E	2.2 (Note 4)

FOR SUPPLY AIR SYSTEMS TRANSPORTING AIR AT 48 DEGREES F AND ABOVE	MATERIAL TYPE	INSULATION THICKNESS (INCHES)
Exposed Rectangular	G	2
Exposed Round	F	1-1/2
Outdoors	O, H	3 (Note 4)

FOR SUPPLY AIR SYSTEMS TRANSPORTING AIR AT LESS THAN 48 DEGREES F	MATERIAL TYPE	INSULATION THICKNESS (INCHES)
Concealed	E	3 (Note 4)
Exposed Rectangular	G	3
Exposed Round	F	2
Outdoors	O, H	3 (Note 4)

FOR RETURN AND EXHAUST AIR SYSTEMS	MATERIAL TYPE	INSULATION THICKNESS (INCHES)
Concealed	E	2
Exposed Rectangular	G	2
Exposed Round	F	1-1/2
Outdoors	O, H	3 (Note 4)

C. Equipment:

EQUIPMENT	MATERIAL TYPE	INSULATION THICKNESS (INCHES)
Air Separator	K	1-1/2
Bypass Water Filter	K	1-1/2
Chilled Water Pumps	G	2
Condenser Water Pump	G	2
Expansion Tank for Chilled Water System	K	1-1/2
Heat Exchangers Shell & Tube, 120 to 200°F Water	N, B	3
Water Chiller Components		
Evaporator Shell	K	1-1/2
Evaporator Water Boxes	L	1-1/2
Economizer Float Chamber	L	1-1/2
Feet	K	1
Suction Piping & Cold Section of Compressor	K	2
Cold Gas Connection to Motor	K	2
Motor on Water Cooled Models	K	1

Note 1: Type C may be used in lieu of Type A, where indicated, at Contractor's option, for pipes up through 2-inch except where heavy duty finish is required.

Note 2: Locate hangers outside of insulation with saddles or thermal shields specified under another section. In the saddle, provide a half section of calcium silicate or cellular glass

equal in thickness to adjoining insulation, or load-bearing PET core, equal to ArmaFix Ecolight, where applicable, sized to support, protect, and carry the load without being crushed or damaged, and vapor sealed, maintaining the thermal integrity of the system. Insulate supports and anchors in contact with pipe the same as piping.

- Note 3: If insulated ductwork is supported from the bottom, provide calcium silicate or cellular glass equal to thickness of the adjoining insulation at the support. Vapor seal and size to carry the load without crushing.
- Note 4: Installed insulation shall be R-6 for indoor insulation and R-8 for outdoor insulation. not achievable with the thickness listed, increase insulation thickness as necessary to comply.
- Note 5: Type P may be used in lieu of Type A, where indicated, at Contractor's option.
- Note 6: Indicated thickness is additional to that specified for the particular piping system. Apply over heat tracing.
- Note 7: Not Used.
- Note 8: Not used.
- Note 9: Not Used.
- Note 10: Not used.

3.10 EXTENT OF INSULATION

- A. Piping: Insulate as designated in Installation Schedule.
- B. Ductwork and Plenums: Insulate the following:
1. Outdoor air.
 2. Return air.
 3. Supply air.
 4. Supply /Return ducts located above roof and outside of building.
 5. Relief and exhaust air ductwork and plenum between motor operated damper or gravity backdraft damper and penetration of building exterior.
 6. Vapor exhaust through cold spaces.
 7. Intake and exhaust plenums.
- C. Equipment: Insulate as designated in Installation Schedule.
- D. Chilled and Condenser water pumps shall be insulated by forming a box around the pump housing. The box shall conform to the requirements of MICA National Insulation Standard 1993, Fourth Edition, Plate 49 except insulation shall be as specified in this section. The box shall be constructed by forming the bottom and sides using joints, which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing, which does not rest on the pump. Joints between top cover and sides shall fit tightly. The top cover shall have a joint forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable. Two coats of Type M3 mastic shall be applied over insulation, including

removable sections, with a layer of glass cloth embedded between the coats. A parting line shall be provided between the box and the removable sections allowing the removable sections to be removed without disturbing the insulation coating. Exposed insulation corners shall be protected with corner angles. The total dry thickness of the finish shall be 1/16-inch. Caulking shall be applied to parting line of the removable sections and penetrations.

END OF SECTION 23 07 00

SECTION 23 08 16 - COMMISSIONING OF HVAC SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Commissioning of HVAC System as outlined in this Section.

1.2 RELATED DIVISIONS

- A. Division 01 - General Requirements
- B. Division 22 - Plumbing
- C. Division 23 - Heating, Ventilating, and Air Conditioning
- D. Division 25 - Integrated Automation
- E. Division 26 - Electrical
- F. Division 28 - Electronic Safety and Security

1.3 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.4 PROJECT CONDITIONS

- A. Provisions of Section 23 05 00, "Basic Mechanical Materials and Methods" shall be made an integral part of this section.
- B. Provide support services for Commissioning of Plumbing HVAC Systems.
- C. Provisions of Section 01 40 00, "Quality Requirements," shall be made an integral part of this section. Commissioning is a particular feature of the Contractor's Quality Control program, with all requirements, responsibilities, and recourse described in Section 01 40 00.

1.5 COMMISSIONING PROGRAM CRITERIA

- A. Intent
 - 1. The intent of HVAC System Commissioning is to assure to the Government, delivery of Plumbing and HVAC systems which are fully functioning in accordance with all specifications and which the Government's personnel are fully trained and equipped to operate, maintain and troubleshoot.

2. The Contractor shall execute a Commissioning Program, which delivers the intended results of a Plumbing HVAC System Commissioning, using whatever personnel, time and resources are required.
 3. This Section provides minimum program requirements; however, the Contractor shall exceed those requirements whenever necessary to achieve the intent of HVAC Commissioning.
- B. Commissioning Agent: The Mechanical Contractor shall assign a qualified individual to function as the Commissioning Agent to coordinate the Commissioning Program.
- C. Definitions and Abbreviations
1. Maintenance Orientation and Inspection: At prescribed times during the work, the Contractor shall walk the Government's Maintenance personnel through the work, orient them to equipment types and locations, assist access for any requested inspections, answer all questions concerning performance of the Work, workmanship standards and quality control. Prescribed training events and submittal of Operation and Maintenance (O&M) Manuals shall precede the inspection.
 2. Equipment Placement Completion: Stage of the work at which the major items of Divisions 22, 23, and 25 equipment have been placed at final locations, but have not received ductwork, piping and electrical connection. Major equipment includes, but is not limited to, heating and cooling plant equipment, dehumidification unit, air handling units and domestic hot water generators.
 3. Distribution Completion: Stage of work at which distribution piping and ductwork have been installed and tested, but not insulated or concealed by further work.
 4. O&M Manuals: Operation and maintenance manuals are specified in Contract Documents.
 5. Testing, Adjusting, and Balancing (TAB): Testing, adjusting, and balancing (air and water flows) of Divisions 22 and 23 equipment as specified in Contract Documents.
 6. Trade Representative: Person who competently represents the work force engaged by the Contractor for the individual trade named. This person shall be completely familiar with the work performed for this contract at all levels of detail of his trade and with coordination to other trades. This person shall be capable of and have authority to execute all commissioning responsibilities of the trade as described in these Contract Documents.
 7. Participate: Attend commissioning events, provide technical expertise or knowledge, equipment, measurements and observation needed or required by the Commissioning Agent or Government. Provide follow-up analysis, equipment data, design data, or other trade or professional service needed in response to commissioning events.
 8. Verify: To positively determine that the measured or observed quantity satisfies all required criteria. Simply performing the test, measurement or observation does not constitute "verification." The test result must also satisfy all design criteria as shown in the Contract Documents. Tests which fail must be repeated at no additional cost to the Government after repairs or adjustments are made, until final verification is achieved.
- D. Scope: For coordination purposes, the entire commissioning scope involving all parties is described here. The responsibilities of Division 23 Trades with respect to commissioning are separated out under Section 3.3 RESPONSIBILITIES.
1. Document HVAC design intent.
 2. Verify that equipment and systems have been properly installed in accordance with the Contract Documents and manufacturer's written installation instructions.
 3. Verify that piping and duct systems have been properly cleaned as specified in Section 23 05 00, "Basic Mechanical Materials and Methods."

4. Verify that equipment has been placed into operation with manufacturer's oversight and approval or in accordance with the manufacturer's written installation instructions.
 5. Verify that system testing, adjusting, and balancing has been properly done in accordance with Section 23 05 93, "Testing, Adjusting, and Balancing."
 6. Assemble Contract Documents and Record Drawings.
 7. Assemble operation and maintenance instructions and submittal data.
 8. Verify the performance of each piece of equipment and each system.
 9. Train Government's personnel in the proper operation of each piece of equipment and each system.
 10. Document warranty-start and end dates.
 11. Assemble all records of code authority inspections and approvals.
 12. Monitor and enforce accessibility of all work versus maintenance requirements of each piece of equipment.
 13. Identify, document and report all deficiencies of the work versus contract specifications and performance requirements, for tracking and correction through the Deficiency Tracking Program.
- E. Commissioning Cost: Each trade and supplier of equipment shall include in his quoted price the cost of furnishing the material requested and manpower necessary for the Operation and Maintenance Manuals, training and system verification.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.1 PREPARATION OF COMMISSIONING PROGRAM

- A. Commissioning program shall be prepared by the Commissioning Agent. The program shall take full cognizance of all intent and specific requirements for the program described in the Contract Documents.
- B. Commissioning program shall be submitted to the Government and shall be subject to approval in all aspects by the Government. The Government reserves the right to require changes in the Commissioning Program or personnel assigned at any time to satisfy the Government's quality assurance within the Commissioning Program.

3.2 COMMISSIONING TEAM

- A. Commissioning Agent shall designate a Commissioning Team consisting of all members needed to execute the approved Commissioning Program. Minimum membership shall include:
 1. Commissioning Agent
 2. Mechanical Trade Representative
 3. Automatic Controls Trade Representative
 4. Testing, Adjusting and Balancing Trade Representative
 5. Energy Management Trade Representative

6. Electrical Trade Representative
7. Government's Representative
8. Government's Maintenance Engineer
9. Engineer of Record
10. Construction Manager

- B. Contractor's personnel shall be made available to execute all aspects of the Commissioning Program until the Government accepts final results. Commissioning Program tasks and meetings may be repeated until the Government is satisfied and will not be fixed as one-time, one-change events for the Contractor.

3.3 RESPONSIBILITIES

A. Government

1. Assign maintenance personnel and schedule them to participate in the various meetings, training sessions and inspections as follows:
 - a. Precommissioning coordination meeting
 - b. Procedures meeting the Testing, Adjusting, and Balancing
 - c. Government's training session
 - d. Verification demonstrations
 - e. Final review and acceptance meeting
2. Provide technicians for video recording of training sessions.
3. Video record construction progress.

B. Commissioning Agent

1. Review all commissioning requirements and intent of the Contract Documents and all related testing, verification and quality control sections.
2. Prepare the Commissioning Program required as part of the CQC program in accordance with Section 01 40 00. Include list of all trade representatives for commissioning events by name, firm and trade specialty.
3. Execute the Commissioning Program, through organization of all meetings, tests, demonstrations, training events and performance verifications described in the Contract Documents and approved Commissioning Program. Organizational responsibilities include preparation of agendas, attendance lists, arrangements for facilities and timely notification to participants for each commissioning event. The Commissioning Agent shall act as chairman at all commissioning events and assure execution of all agenda items. The Commissioning Agent shall prepare minutes of every commissioning event, send copies to all in attendance and the CQC system manager within five working days of the event.
4. Review the plans and specifications with respect to their completeness in all areas relating to the Commissioning Program. This includes ensuring that the commissioning guidelines have been followed and that there are adequate devices included in the design to ensure the ability to properly test, adjust and balance the systems and to document the performance of each piece of equipment and each system. Any items required, but not shown, shall be brought to the attention of the Contractor prior to submittal of shop drawings.
5. The plan and specification review by the Commissioning Agent does not include any responsibility for the system evaluation, adequacy of the system to meet design intent,

- capacity of the system, quality control check or any of the other elements of the system design which are the strict responsibility of the Engineer of Record.
6. Schedule a pre-commissioning coordination meeting within 90 days of the award of the contract, at some convenient location and at a time suitable to the Contractor and Engineer of Record. This pre-commissioning meeting will be for the purpose of reviewing the complete commissioning program and establishing tentative schedules for maintenance orientation and inspections, O&M submittals, training sessions, system flushing and testing, job completion, system startup and testing, adjusting and balancing work.
 7. Schedule first Government Plumbing and HVAC training just prior to the maintenance orientation and inspection. This session will be attended by the Government's Representative, Mechanical Trade Representative, Engineer of Record and Commissioning Agent. The Engineer of Record will conduct this session giving an overview of the system, the system design goals and the reasoning behind the selection of the equipment.
 8. Schedule the first Plumbing and HVAC maintenance orientation and inspection following the initial training session. The maintenance orientation and inspection will be conducted by the Mechanical Trade Representative. The emphasis on this maintenance orientation and inspection will be an observation of the equipment location with respect to accessibility. Prepare minutes of this meeting, with separate summary of deficiency findings by the Government and Commissioning Agent. Distribute to those in attendance and CQC by the systems manager.
 9. Receive and perform quality control on the operation and maintenance (O&M) manuals as submitted by the Contractor. Ensure that they follow the specified outline and format. Insert systems description as provided by the Engineer of Record.
 10. Schedule the second Plumbing and HVAC maintenance orientation and inspection at the distribution completion stage. The emphasis on this maintenance orientation and inspection will be an observation of the equipment location with respect to accessibility. The maintenance orientation and inspection shall be conducted by the Mechanical Trade Representative and will be attended by the Commissioning Agent, the Engineer of Record, and the Government's Representative. Prepare minutes of this meeting, with separate summary of deficiency findings by the Government and Commissioning Agent. Distribute to those in attendance and CQC system manager.
 11. Adequate accessibility for maintenance and component replacement or repair is the Contractor's responsibility and will be checked by the Commissioning Agent at shop drawings, and during initial and final CQC phases for each item of equipment.
 12. Witness the HVAC piping test and flushing procedure. Document the results and incorporate the documentation in the O&M manuals. Prepare report of this observation, with separate summary of deficiency finds by the Commissioning Agent. Distribute to Government and CQC system manager.
 13. If ductwork testing and cleaning is specified, witness those tests, document the results and incorporate in the O&M manuals.
 14. Schedule a meeting with the Testing, Adjusting, and Balancing (TAB) Trade Representative prior to the start of the testing, adjusting and balancing procedure. This meeting should be attended by the Government, Mechanical Trade Representative, Commissioning Agent, and Engineer of Record. The TAB Trade Representative will outline the TAB procedure and get concurrence from the Engineer of Record and Commissioning Agent. Ensure that the TAB Trade Representative has all forms required for the job database and understands their importance and use.
 15. Schedule the Government training sessions. These training sessions are to be attended by the Government, Commissioning Agent, Engineer of Record, Contractor, respective Contractor's Trade Representative and equipment suppliers as necessary. The format will follow the outline in the O&M manuals. Schedule the third maintenance orientation and inspection with hands on training as a part of the training program.

16. Upon receipt of notification from the Contractor that the system has been started, that all air, water and control systems have been started, tested, adjusted and balanced and that the systems and equipment are functioning as designed and specified, schedule the verification demonstration. These demonstrations will be conducted by the Contractor and his TAB Contractor and Automatic Controls Trade Representative and witnessed by the Government. Prepare minutes of each verification event, with separate summary of deficiency findings by the Government and Commissioning Agent. Distribute to those in attendance and CQC system manager.
17. Review record drawings for accuracy against installed systems. Require changes to achieve accurate drawings.
18. Prepare final commissioning report in accordance with Article 3.8 and submit to the Government. Schedule final review with Government. Present all documentation and turn over signed acceptance of the system by the Government and Commissioning Agent to the Contractor.

C. Engineer of Record

1. Provide documentation and design intent. Submit to the Commissioning Agent for incorporation into the appropriate sections of the O&M Manuals.
2. Provide Plumbing and HVAC System design parameters. Submit to the Commissioning Agent for incorporation into the appropriate sections of the O&M Manuals.
3. Attend initial pre-commissioning coordination meeting to be scheduled by the Commissioning Agent within 90 days of the award of the contract.
4. The Engineer of Record shall specifically verify adequate maintenance accessibility for each piece of equipment in shop drawings and actual installation. Periodic inspections are part of the Engineer of Record's construction administration duties.
5. Conduct the first Plumbing and HVAC training session on the overview of the system design, the system design goals and the reasoning behind the selection of equipment.
6. Participate in the first Plumbing and HVAC maintenance orientation and inspection following the first training session.
7. Provide sections on system description as described in this Section, for inclusion in the O&M Manual and forward to the Commissioning Agent.
8. Participate in the second Plumbing and HVAC maintenance orientation and inspection at the distribution completion stage.
9. Attend initial meeting with TAB Trade Representative as scheduled by Commissioning Agent.
10. Attend the classroom portion of the Government's training sessions. Attendance at the hands-on demonstration is optional.
11. Review TAB report from Contractor against design requirements. Issue a report noting deficiencies requiring correction to the Commissioning Agent.

D. Contractor

1. Include cost for commissioning requirements in the contract price.
2. Include commissioning requirements in the mechanical and electrical subcontracts and ensure full cooperation of all parties in the Commissioning Program.
3. Provide an acceptable Commissioning Agent to prepare and coordinate execution of the Commissioning Program. Provide the Commissioning Agent with means and authority to execute Commissioning Program.
4. Coordinate the interface of the Commissioning Program to other elements within the CQC program, including deficiency tracking.

E. Mechanical Trade Representative

1. Include cost for commissioning requirements in the contract price.
2. Include requirements for submittal data, O&M data and training in each purchase order or subcontract written.
3. Enlist the support of the Commissioning Agent to ensure cooperation of other sub-trade representatives such as the energy management and automatic controls, electrical, plumbing, fire protection and security as necessary.
4. Ensure cooperation and participation of specialty sub-trade representatives such as sheet metal and piping, testing, adjusting, and balancing, water treatment, and refrigeration.
5. Ensure participation of major equipment manufacturers and their representatives.
6. Attend initial pre-commissioning coordination meeting scheduled by the Commissioning Agent. Prepare necessary preliminary schedule for maintenance orientation and inspections, O&M manual submission, training sessions, pipe and duct system testing, flushing and cleaning, equipment startup, testing, adjusting and balancing start and job completion for use by the Commissioning Agent. Update schedule as appropriate throughout the construction period.
7. Attend initial training session and conduct maintenance orientation and inspection at the equipment placement completion stage. Update drawings to record the conditions to date, and review with the Commissioning Agent prior to the maintenance orientation and inspection meeting.
8. Gather O&M data on all equipment, assemble in binders as required by this Section. Submit to Commissioning Agent prior to the distribution completion stage.
9. Conduct the second maintenance orientation and inspection at the distribution completion stage. Update drawings to record the conditions to date, and review with the Commissioning Agent prior to the inspection.
10. Notify the Commissioning Agent of the time for the piping system pressure tests and flushing.
11. Notify the Commissioning Agent of the time for start of the TAB work. Attend the initial TAB meeting for the review of the TAB procedures.
12. Participate in and schedule vendors and Trade Representatives to participate in the training sessions as set up by the Commissioning Agent.
13. Conduct a maintenance orientation and inspection with hands on training. Update drawings to the record condition to date and review with the Commissioning Agent prior to the orientation.
14. Provide written certification that the following work has been completed in accordance with the plans and specifications and that they are functioning as designed. Where the work has been sub-contracted, the sub-trade representative shall be responsible for the initial certification with the HVAC Trade Representative recertifying that he has inspected the work and that it has been completed and functioning as designed. This certification must be submitted to the Commissioning Agent prior to the final verification.
 - a. HVAC equipment including, all fans, air handling units, dehumidification units, ductwork, dampers, terminals and all Division 23 equipment.
 - b. Refrigeration equipment, pumping systems and heat rejection equipment.
 - c. Fire stopping in the fire rated construction including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.
 - d. Building control systems are functioning to control HVAC equipment control systems.
 - e. Sprinkler system(s).

15. Demonstrate the performance of each piece of equipment to the Commissioning Agent. Schedule the TAB, HVAC controls, energy management and other sub-trade representatives as may apply to demonstrate the performance of the equipment and systems.
16. Turn over set of record markups to the Engineer of Record for his final incorporation into the Record Documents.
17. Coordinate this Commissioning Program with the Electrical System Commissioning Program specified in Division 26.

F. Testing, Adjusting and Balancing Trade Representative

1. Include cost for commissioning requirements in the contract price.
2. Attend initial pre-commissioning coordination meeting scheduled by the Commissioning Agent.
3. Attend the TAB review meeting scheduled by the Commissioning Agent. Be prepared to discuss the TAB procedures that will be followed in testing, adjusting and balancing the HVAC system.
4. Participate in training sessions as set up by the Commissioning Agent.
5. At the completion of the TAB work, notify the Mechanical Trade Representative, and demonstrate to the Commissioning Agent the performance of the equipment covered by the TAB sub-contract as specified under "Verification of Performance" in this section.
6. Repeat any measurement contained in the TAB report where required by the Commissioning Agent for verification or diagnostic purposes.

G. Automatic Controls Trade Representatives

1. Include cost for commissioning requirements in the contract price.
2. Attend initial pre-commissioning coordination meeting scheduled by the Commissioning Agent.
3. Participate in training sessions as set up by the Commissioning Agent.
4. At the completion of the automatic controls /and energy management/ systems start-up and adjustment work, notify the Mechanical Trade Representative, and demonstrate to the Commissioning Agent the performance of the automatic controls /and energy management/ systems.

H. Equipment Suppliers and Miscellaneous Trade Representatives

1. Include cost for commissioning requirements in the contract price.
2. Attend initial pre-commissioning coordination meeting scheduled by the Commissioning Agent.
3. Participate in training sessions as set up by the Commissioning Agent.
4. Demonstrate performance of equipment as applicable.

3.4 OPERATION AND MAINTENANCE MANUALS

A. General Requirements

1. Initial preparation shall be the responsibility of the Mechanical Trade Representative.
2. Quantity: Four. See Section 23 05 00, "Basic Mechanical Materials and Methods."/
3. Format: Three inches thick, 8-1/2 by 11-inch loose-leaf D-ring binders. Use as many as required. Do not overload binders.

4. Content

- a. Cover sheet.
- b. Table of contents (as follows):
 - 1) Description of Systems: The description of systems will be provided by the Engineer of Record for insertion at the time of review and before turn-over to the Commissioning Agent. This description of systems will be an updated version of the narrative included in Section 23 05 00 - "Basic Mechanical Materials and Methods" and will be an overview of the entire system. Simplified, professional-drawn system diagrams shall be provided on 11 by 17-inch sheets. These shall include chilled water system, condenser water system, heating system, supply air systems and exhaust systems. These shall show major pieces of equipment such as pumps, chillers, control valves, expansion tanks, coils, service valves, etc. Unless they are essential to understanding system operation, equipment pass arrangement, etc. is not important. Copies of these diagrams shall be framed under plexiglas and mounted in an appropriate place. Framing and mounting shall be the responsibility of the Mechanical Trade Representative. It will be the basis for the starting of the Government's instruction program.
 - 2) Design Parameters: The design parameters will be provided by the Engineer of Record. It will be a detailed listing of the design criteria on a room by room and system by system basis used as a basis for the design. This will be inserted by the Engineer of Record at the time of review and before turnover to the Commissioning Agent.
 - 3) Specification Section "21 13 00," Fire Suppression," Section 23 05 00, "Basic Mechanical Materials and Methods" through Section 23 82 39, "Unit Heaters."

B. Detailed Preparation Requirements

- 1. The cover sheet shall list: project name, location, architect, structural, mechanical and electrical engineering firm names with addresses, telephone numbers and project managers' names for this project.
- 2. Each major heading in the table of contents shall have a large distinctive, clearly marked, non-erasable, plastic encased tab.
- 3. Each section shall have the following sub-tabs, which shall be similar to the main tabs but of a different color:
 - a. Specifications: The specification shall be copied and inserted complete with all addenda.
 - b. Submittal and Product Data: This section shall include all approved submittal data. If submittal was not required for approval, descriptive product data shall be included.
 - c. Installation Instructions: If the product, such as piping, etc., does not have any written installation instructions, include a statement "Manufacturer's Written Installation Instructions not Available -Product Installed in Accordance with Specifications and Good Practice."
 - d. Operation and Maintenance Instructions: These shall be the written manufacturer's data edited to omit reference to products or data not applicable to this installation.
 - e. Parts List: These shall be edited to omit reference to items, which do not apply to this installation.
 - f. Equipment Supplier: This section shall include the name, address and telephone number of the manufacturer's agent and service agency supplying or installing and starting up of the equipment.

- g. Warranties: This section shall include applicable warranties to each section.
- h. Commissioning Checklist: This will be filled out by the Contractor with the specified data and submitted data and inserted into the manual for submission to the Engineer of Record. A copy shall be given to the TAB Trade Representative so that TAB data can be added. Upon completion of this entry, the form shall be forwarded with the certification of system completion and commissioning request.
- i. System Description: This section shall include that portion of the overall description included in the beginning of the manual as it applies to each sub-section. In sections such as piping, valves and fittings, a statement shall be included. In sections such as pumps, the pump designations and their use shall be as listed in the equipment schedule, for example,
 - 1) 04 03 CH PMP-1 Chilled Water Pump
 - 2) 04 03 CW PMP-1 Condenser Water Pump
 - a) See Contract Documents for complete chilled water system description:
 - 3) 04 03 HW PMP-1 Lead Heating Water Pump
 - 4) 04 03 HW PMP-2 Lag Heating Water Pump
 - a) See Contract Documents for complete hot water system description.
 - 5) Specific system description will be added by the Engineer of Record when the manuals are submitted for review and prior to forwarding to the Commissioning Agent.
- j. Automatic Controls Description: This shall be included in each section covering controlled equipment. It shall include the description from the approved temperature control submission, complete with schematic diagram showing piping arrangement and control location on 11 by 17-inch sheet. This data shall be provided by the Automatic Controls Trade Representative in a form suitable for insertion into the O&M Manuals by the Mechanical Trade Representative and for review by the Engineer of Record and include but not be limited to:
 - 1) Air Handling Units (include any Return Air Fans, any humidifiers, and any associated Exhaust Fans).
 - 2) Air Rotation Units (include any Return Air Fans, any humidifiers, and any associated Exhaust Fans).
 - 3) Chillers (include complete chilled water plant description including Pumps and Cooling Tower control).
 - 4) Fan Coil Units.
 - 5) Fans.
 - 6) Unit Heaters.
 - 7) Ductless Split Systems.
 - 8) Humidifier Pump Stations.
 - 9) Chemical Treatment.
 - 10) RO system.
 - 11) Skid Packaged and Packaged equipment.
 - 12) A copy of these automatic control diagrams shall be framed under plexiglas and mounted next to the controlled equipment or in an appropriate place by the Automatic Controls Trade Representative.

- k. Condensed Operating Instructions: This section shall include condensed instructions for start-up, shut-down, emergency operation, safety precautions, unusual features and troubleshooting suggestion. Where control is clearly covered in the controls description, it is not to be duplicated here. A copy of these instructions shall be framed under plexiglas, and placed adjacent to the equipment where they can be easily read by operating personnel. Instructions mounted outdoors shall be suitably weather protected. Framing and mounting shall be the responsibility of the Mechanical Trade Representative. These instructions shall be provided for chillers, pumps, heat rejection equipment, air handling units, exhaust fans, and controls.
 - l. Preventative Maintenance Instructions: This section shall include condensed typewritten excerpts from the manufacturer's written instructions on weekly, monthly, quarterly, annually, etc. This summary shall be prepared by the Mechanical Trade Representative with help from the equipment supplier. It will be reviewed by the Engineer of Record prior to turning over to the Commissioning Agent. It shall be prepared for all items listed under Condensed Operating Instructions above.
 - 4. Testing, Adjusting, and Balancing section shall contain the following
 - a. Specifications
 - b. Submittals
 - c. TAB Data: This shall be the final TAB report. It will probably have to be added after the Government has received his training and the O&M manuals. Payment for TAB work will be withheld until the data is received and approved and the TAB instructed session is complete. The Contractor shall be responsible for incorporating this data into the O&M manual.
 - 5. Commissioning of HVAC Systems section shall contain the following:
 - a. Specifications
 - b. Approved Commissioning Program for HVAC System
 - c. Final Report of the Commissioning Agent on HVAC Systems
 - C. Submittal Requirement
 - 1. The O&M Manuals shall be submitted at the equipment placement completion stage, which shall be defined as that time in the project when the major pieces of equipment have been set in place ready for connection to piping and duct systems.
 - 2. In order to ensure that the O&M Manuals are submitted in a timely manner and to give a reasonable time for compliance, any progress payments for Division 23 work beyond 60 percent scheduled value shall not be approved until this submittal has been received and provisionally approved.
- 3.5 TRAINING OF GOVERNMENT'S OPERATORS
- A. The Government's representatives shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.
 - B. Commissioning Agent, in cooperation with the Engineer of Record and Contractor, will be responsible for scheduling the training, which shall start with classroom sessions followed by

hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shutdown and any emergency procedures.

- C. Training shall be conducted in a minimum of three parts:
 - 1. The first part, or systems orientation portion, shall be scheduled prior to the equipment placement maintenance orientation and inspection. This training session will include a review of all systems using the simplified system schematics including chilled water systems, condenser water or heat rejection systems, heating systems, supply air systems and exhaust system.
 - 2. The second part, or equipment portion, shall be scheduled as soon as possible after start-up of the equipment.
 - 3. The third part, or the commissioning review portion, shall be conducted after completion of the Commissioning verification.
- D. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
- E. The training sessions shall follow the outline in the Table of Contents of the Operation and Maintenance Manuals.
- F. The Engineer of Record will attend all training sessions and conduct the first session on the overall system design concept and the design concept portion of equipment section.
- G. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the O&M Manuals and shall include a review of the written O&M installations emphasizing safe and proper operating requirements and preventative maintenance. Training shall be included for all major pieces of equipment including pumps, chillers, heat rejection equipment, air conditioning units, air handling units, fans, controls and water treatment systems. Equipment training shall be done by qualified service engineers employed by the manufacturers or their qualified sales representatives. The operation and function of the equipment in the system shall be discussed.
- H. Each classroom training session shall be followed by an inspection, explanation and demonstration of the equipment. The start-up and shutdown modes of operation shall be demonstrated.
- I. The Contractor shall attend all sessions and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
- J. The Automatic Controls Trade Representative shall attend all sessions and be prepared to conduct the controls portion of the training as it relates to each equipment section.
- K. The Automatic Controls Trade Representative shall conduct the training session on the controls system hardware and software.
- L. The piping, insulation and sheet metal trade representatives shall conduct sessions on their respective trades with emphasis on any peculiarities of the systems, pressure limitations and maintenance requirements.

- M. The TAB Trade Representative shall conduct a training session reviewing the procedures and methods used in the TAB process, shall review the TAB data and shall demonstrate use of test equipment which may have been turned over to the Government and shall point out the locations of all pitot traverse locations for the Government's future use.
- N. The Commissioning Agent shall conduct a final session summarizing the Commissioning Program.

3.6 NOTIFICATION OF SYSTEM COMPLETION AND REQUEST FOR FINAL HVAC SYSTEM COMMISSIONING VERIFICATION

- A. When systems are ready for final commissioning verification, the Mechanical Trade Representative shall notify the Commissioning Agent, in writing. Commissioning data sheets must be complete through the column labeled "Balanced" and included with the request.
- B. Should the verification test reveal that the equipment is not performing as specified or control operation is not acceptable, the Contractor will be entitled to one re-inspection of any failed item at no additional cost.
- C. Should the verification test determine that the equipment is still not performing as specified or control operation is not acceptable on the second inspection, the time and expenses of the Engineer of Record, if applicable, and Government to make further verification shall be considered as additional cost to the Government. The total sum of such costs shall be deducted from the final payment to the Contractor.

3.7 TESTS

- A. A test plan shall be developed individually for each subsystem, which will define the tests required to ensure that the system, functions, and programs meet technical, operational, and performance requirements. The test plan shall define the schedule for the test exercises, including initial tests, calibration tests, testing of control sequence, and simulation programs. The test plan shall identify the equipment and facilities required for the test.
- B. Prior to substantial completion of the environmental control system, the system shall undergo a series of tests to verify its operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, performed their own complete series of tests and debugged the system.
- C. The tests described in this Section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process. As a minimum, the Contractor shall perform their own set of tests prior to those required herein so as to assure the Engineer of Record and Commissioning Agent that the system can successfully complete the tests required herein prior to their execution. Failure of the Contractor to perform their own set of tests first may be cause for rescheduling the tests herein and delay of project substantial completion.

3.8 COMMISSIONING REPORT REQUIREMENTS

- A. The Commissioning Agent shall document each commissioning event with meeting minutes or a report. The documents shall separately list deficiencies observed or discovered during the event.

The document shall be distributed to Commissioning Team members and the CQC system manager.

- B. The Commissioning Agent shall also document any noted apparent operational deficiencies, which might be the result of a design deficiency such as a condition where the equipment is performing as specified yet the space is not cool (or warm). Bring this to the attention of the Engineer of Record for confirmation and resolution.
- C. The Commissioning Agent shall prepare a final formal report to the Government, which will include a narrative in the form of an Executive Summary of the results of the Program, impressions of the training sessions, and the level of operating competence and a certification that the verification of each item is complete and all systems are operating as intended
- D. Transmitted with the report shall be the edited Operation and Maintenance Manuals including:
 - 1. Commission Data Sheets
 - 2. Warranties
 - 3. Permits and Inspection Reports
 - 4. TAB Balancing Reports.
- E. The report shall include the Functional Performance Test (FPT) data sheets.

3.9 TEST PROCEDURES

- A. Submit for approval detailed FPT (Functional Performance Test) procedures corresponding to the FPT criteria in Acceptance Criteria in this Section. FPT procedures shall be detailed test instructions, written with sufficient step-by-step information to allow a test to be repeated under identical conditions. List the value for all setpoints and inputs, positions of adjustable devices and acceptable results for each condition tested. Provide a unique alphanumeric identification for each FPT procedure.
- B. Submit for approval test procedure check-off sheets. Number each test procedure check-off item with the same number as the corresponding FPT procedure identifier.
- C. Demonstrate successful execution of FPTs listed under Acceptance Criteria in this Section. Sign-off each successful test and obtain the sign-off of the Commissioning Agent or other Government-designated witness.

3.10 ACCEPTANCE CRITERIA

- A. The primary purpose of this section is to witness and verify all of the sequence of operations of the systems shown on the Mechanical Drawings; tests identified in this Section and additionally called for in Section 25 00 00, "Chiller Plant Control System", 25 00 10, "Hot Water Skid Control System", and 25 00 20, "Air Handlers Control System" of the Contract Documents, and verify equipment capacities submitted. Provide trend logs for each test, recording data every two minutes.
- B. Each function and test shall be performed under conditions, which simulate as close to an actual condition as possible. To that end, the Contractor shall provide all necessary materials and temporary systems modifications to provide flows, pressures, temperatures, etc. necessary to false

load the system being tested in order to prove and verify proper operation. Reliance on simulated signal from DDC system or other indirect indicators is not acceptable. At satisfactory completion of all verified tests, the building system being tested shall be returned to the condition required by the Contract Documents as a complete and operational system.

- C. Demonstrate to the Government's Representative successful execution of the following FPTs (functional performance tests) in accordance with approved FPT procedures as described in Test Procedures in this Section. The FPTs shall be completed after all other startup and balancing procedures are completed. All systems shall be operational for the FPTs. The FPTs are a check that the system is operating as designed and installed.
- D. System Calibration: Upon completion of the installation, the system installer shall start up the system and perform all necessary testing and diagnostics to ensure proper operation. Submit to the Commissioning Agent documentation on the calibration of all equipment, including each sensor or control device. Documentation shall include:
 - 1. Step-by-step check-off list of the calibration of each sensor, monitoring/control device and each piece of controlled equipment.
 - 2. Calibration records describing the actual calibration procedures and all test equipment used. Calibration test equipment shall have an accuracy at least equal to the tolerance of the device being adjusted. Test equipment shall provide stabilized field measurements in no more than 30 seconds per reading, utilizing a digital readout display where commercially available.
 - 3. The Results of all Inspections and Tests: Documentation shall be accompanied a by letter from the Contractor to the Commissioning Agent stating that calibration of the system is complete.
- E. System Test
 - 1. The system test shall be performed after total system calibration and shall consist of an operational test of each system in the presence of the Commissioning Agent or Government's Representative. The systems will be tested with points selected at random by the Commissioning Agent. The executive routine and each application program will be tested, the performance of the Automatic Control's Sequences of Operations shall be demonstrated, and transmission link accuracy, sensor accuracy and control operation will be reviewed.
 - 2. Systems will not be accepted on a point-by-point or subsystem basis, but only as a whole complete operating system. All executive routine and software functions shall be fully functional. Test a statistically significant sample of all sensors. The size of the sample shall be determined to achieve a confidence level in the validity of the sample of 95 percent. The Commissioning Agent will select at random the points to be tested.
- F. Commissioning Agent shall review all of the software for proper point-to-point operation. Upon review of software, a point-to-point test of the environmental control system installation shall commence point-to-point verification. The Contractor shall provide two people equipped with two-way communication and shall test actual field operation of each control and sensing point. The purpose is to test the calibration, response, and action of every point. Any test equipment required to provide the proper operation of the environmental control system shall be provided by and operated by the Contractor. The Test Engineer will be present to oversee, observe, and review the test.
 - 1. Point-to-point Verification (all points, input and output):

- a. Device and Continuity Check:
 - 1) Sensor to controller check or sensor to operators' control station check as applies.
 - a) Command to output
 - b) Control/monitored device response check
 - c) Virtual points and loop control points are not tested as part of the point-to-point testing.
- 2. Calibration Check (all sensors). Calibrate sensors at both extremes of operating conditions and at midpoints.
 - a. Temperature (sensors)
 - 1) Immersion:
 - a) Icebath
 - b) Boiling water (altitude)
 - 2) Room:
 - a) Side-by-side
 - b) Independent thermometer check
 - 3) Duct:
 - a) (Side-by-side
 - b) (Independent thermometer check
 - b. Pressure Sensor (Calibrated per AABC Standards)
 - 1) Water
 - 2) Air
 - 3) Differential pressure
 - 4) Level
 - c. Humidity (Calibrated per AABC Standards)
 - 1) Room
 - 2) Duct
 - 3) Outdoor air (OA)
 - a) Sling psychrometer
 - b) Hand-held digital humidity meter (thin film polymer sensor)
 - d. Flow
 - 1) Ultrasonic flow meter
 - 2) Differential pressure on Venturi/orifice

- G. When the point-to-point test is successfully completed, a series of hardware software systems tests shall be performed. The Contractor shall provide two people equipped with two-way communication for these tests. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:
1. DC Loop response: The Contractor shall supply a trend data output in graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in setpoint, which represents a change in the actuator position of at least 25 percent of its full range. The sample rate of the trend shall be from one to three minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that yields unreasonably under or over-damped control shall require further tuning by the Contractor. Resubmit trend data following all loop tuning.
 2. Interlocks and other sequences for each interlock.
 3. HVAC control system control under HVAC equipment failure.
 4. HVAC operation under HVAC control system equipment failure, including standalone operations during communications systems failure.
 5. Battery backup.
 6. HVAC control system control under power failure/restart.
 7. Demand limiting: The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a one-half hour period. Included in the trend shall be the building kW, demand limiting setpoint, and the status of all shedable equipment outputs.
 8. Each reset schedules.
 9. Each HVAC control system alarm reporting capability.
 10. Optimum start/stop: The Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trend shall include the output status of all optimally started and stopped equipment, and the temperature sensor inputs of all affected areas.
 11. HVAC control system operation during a fire alarm.
 12. The Commissioning Agent shall be present to oversee, observe, and review the tests.
- H. Mechanical contractor shall supply the Commission Agent with two debugged printouts of all HVAC control system software. Also supply all user's programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:
1. Point database.
 2. All custom control program written in the HVAC control system control language.
 3. All parameters required for proper operation of the HVAC control system and utility firmware such as start/stop routines, etc.
 4. Printouts or plotted copies of the interactive system graphics.
- I. Software printout shall be fully documented for ease of interpretation by the Commissioning Agent and Government, without assistance from the Automatic Controls Subcontractor. English language descriptions shall be either integrated with or attached to the environmental control system printout. The intent of supplying the above software printouts is to determine compliance with specification requirements. Specifically, the following shall be documented:
1. All point (I/O and virtual) names.
 2. All HVAC control system programming language commands, functions, syntax, operators, and reserved variables.
 3. Use of all HVAC control system firmware.

4. The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.
 5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, and chiller and heat exchanger optimization.
 6. Provide a table of contents to the documentation, which locates the sections of the documentation and describes which programs or program sections are for each piece of controlled/monitored equipment.
 7. Provide flow charts using IEEE symbol nomenclature that demonstrates the software's algorithms and flow logic.
- J. The HVAC control system will not be accepted as meeting the requirements of substantial completion until all tests described in this section have been performed to the satisfaction of the Commission Agent. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the substantial completion requirements if stated as such in writing by the Commissioning Agent. Such tests shall be performed as part of the HVAC control system warranty.

3.11 AIR HANDLING UNITS

A. Mixed Air Control

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above.
2. Functions to be Tested: Damper and control valve actuation in order to maintain temperature setpoint and minimum outdoor air.
3. Conditions of the Test: Test damper modulation capability when outdoor air temperature is below 45 degrees F, around 60 degrees F and above 82 degrees F. Test system under 25, 50, 75 percent and 100 percent air flow within the design tolerances.
4. Acceptable Results: Every mode of the system operation and every item in the control description shall be proved. Retest operation with carbon dioxide concentrations above 800 ppm in the return air stream.

B. Pre-heating (if present), Reheating and Cooling Coil Capacity

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above.
2. Functions to be Tested: Capacity of the heating and cooling coils.

3. Conditions of the Test: Conditions at heating coil shall be as scheduled on drawings. Measure and record leaving heating coil and cooling coil temperature, water flows, valve positions and air flow for a period of 20 minutes. Repeat test while increasing coil entering conditions by 15-degree F intervals up to the scheduled cooling coil entering coil air temperature. Test coils at design conditions and 100 percent airflow; retest at 25, 50, and 75-percent airflow.
4. Acceptable Results: Coils provide the scheduled/submitted capacities, and supply air temperature is maintained throughout the test; when the heating coil is operating the cooling coil has modulated closed; and while the cooling coil is operating, the heating coil has modulated closed. Verify tight shutoff of heating and cooling coil valves.

C. Freeze Protection

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above.
2. Functions to be Tested: Freeze protection alarm, valve and damper responses.
3. Conditions of the Test: Provide means to falsely "chill" freeze protection thermostat: do NOT subject coils to a true freeze condition.
4. Acceptable Results: The freeze protection sequence scheduled on the drawings is confirmed.

D. Supply Fan Exhaust Fan Interlock

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above and associated exhaust systems.
2. Functions to be Tested: Confirm interlock function between supply fans and their associated exhaust fans.
3. Conditions of the Test: Begin the test with all the associated fans of the system (as described on the control diagrams) "ON". Shut off each of the fans individually at the disconnect while the remaining are "ON".
4. Acceptable Results: The unit confirms the interlock function.

E. Supply Fan Starting and Stopping

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above and fire alarm systems.

2. Functions to be Tested: Stopping of supply air fans as per control drawings.
 - a. Freeze protection thermostat shutdown (see Paragraph 3.11.C)
 - b. General fire alarm
 - c. Starter or Disconnect Manual Shutdown (Coordinate with paragraph 3.11.D)
 - d. DDC Operator Command
3. Conditions of the Test: Begin the test with all the associated fans of the system (as described on the control diagrams) "ON." Each function shall be performed individually.
4. Acceptable Results: The control system is confirmed.

F. Humidity Control

1. System/Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. 04 03 RO PMP-1 and 2, humidifier pump station.
 - e. Control system for all of the above and associated air distribution and control systems.
2. Each humidifier and associated humidistats and control valve shall be tested.
3. Functions to be Tested:
 - a. Modulation of the humidifier control valve in correlation with the humidistat.
 - b. High limit humidistat.
 - c. Air flow switch.
4. Conditions of the Test: Begin the test with humidity of return at 40 percent RH. Record position of humidifier control valve and verify humidifier is off for 20 minutes. Reduce relative humidity down to 25 percent RH over 5 minutes. Observe operation of humidifier and associated control valve.
5. Acceptable Results:
 - a. The humidifier control valve is closed and humidifier is non-operational above 30 percent RH and control valve modulates open and relative humidity level is maintained when return air is below 30 percent RH.
 - b. High limit humidistat prevents RH higher than setting.
 - c. Humidifier valve closes on loss of airflow.

G. Space Pressurization

1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above.
2. Functions to be Tested: space pressurization, damper responses.
3. Conditions of the Test: Alter exhaust rates from spaces and open and close doors..

- H. Acceptable Results: Space pressure scheduled on the drawings is maintained and confirmed.
- I. Loss of Control Power
 - 1. System/Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above, and associated air distribution and control systems.
 - 2. Functions to be Tested: Fail safe position of control dampers and valves when control power is lost; and return to normal operation once power is restored.
 - 3. Conditions of the Test: Begin the test with all systems operating; disengage control power. Restore power after verification of results on a loss of control power.
 - 4. Acceptable Results: valves and dampers fail to their "safe" positions and return to normal operation upon restoration of power.
- J. Loss of Power
 - 1. Equipment to be Tested:
 - a. 04 02 SA AHU-1.
 - b. 04 03 SA AHU-1.
 - c. 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
 - d. Control system for all of the above, and associated air distribution and control systems.
 - 2. Functions to be Tested: Shutdown of the units in an emergency power mode and their return to normal operation once power is restored.
 - 3. Conditions of the Test: Begin the test with all systems operating; disengage normal power, switch to emergency power and then restore normal power.
 - 4. Acceptable Results: Unit cycles off and outdoor air dampers close; and the system returns to power per the specified sequence.

3.12 AIR ROTATION UNITS

- A. Mixed Air Control
 - 1. Equipment to be Tested:
 - a. 04 00 SA ARU-1, 2, and 3, control system.
 - 2. Functions to be Tested: Damper and control valve actuation in order to maintain temperature setpoint and minimum outdoor air.
 - 3. Conditions of the Test: Test damper modulation capability when outdoor air temperature is below 45 degrees F, around 60 degrees F and above 82 degrees F. Test system under 25, 50, 75 percent and 100 percent air flow within the design tolerances.
 - 4. Acceptable Results: Every mode of the system operation and every item in the control description shall be proved. Retest operation with carbon dioxide concentrations above 800 ppm in the return air stream.

B. Heating, and Cooling Coil Capacity

1. Equipment to be Tested:
 - a. 04 00 SA ARU-1, 2, and 3, control system.
2. Functions to be Tested: Capacity of the heating and cooling coils.
3. Conditions of the Test: Conditions at heating coil shall be as scheduled on drawings. Measure and record leaving heating coil and cooling coil temperature, water flows, valve positions and air flow for a period of 20 minutes. Repeat test while increasing coil entering conditions by 15-degree F intervals up to the scheduled cooling coil entering coil air temperature. Test coils at design conditions and 100 percent airflow; retest at 25, 50, and 75-percent airflow.
4. Acceptable Results: Coils provide the scheduled/submitted capacities, and supply air temperature is maintained throughout the test; when the heating coil is operating the cooling coil has modulated closed; and while the cooling coil is operating, the heating coil has modulated closed. Verify tight shutoff of heating and cooling coil valves.

C. Supply Fan Starting and Stopping

1. Equipment to be Tested:
 - a. 04 00 SA ARU-1, 2, and 3, control system and fire alarm systems.
2. Functions to be Tested: Stopping of supply air fans as per control drawings.
 - a. General fire alarm
 - b. Starter or Disconnect Manual Shutdown (Coordinate with paragraph 3.11.D)
 - c. DDC Operator Command
3. Conditions of the Test: Begin the test with all the associated fans of the system (as described on the control diagrams) "ON." Each function shall be performed individually.
4. Acceptable Results: The control system is confirmed.

D. Humidity Control

1. System/Equipment to be Tested:
 - a. 04 00 SA ARU-1, 2, and 3, control system, and associated air distribution and control systems.
 - b. 04 03 RO PMP-1 and 2, humidifier pump station.
2. Each humidifier and associated humidistats and control valve shall be tested.
3. Functions to be Tested:
 - a. Modulation of the humidifier control valve in correlation with the humidistat.
 - b. High limit humidistat.
 - c. Air flow switch.
4. Conditions of the Test: Begin the test with humidity of return at 40 percent RH. Record position of humidifier control valve and verify humidifier is off for 20 minutes. Reduce relative

humidity down to 25 percent RH over 5 minutes. Observe operation of humidifier and associated control valve.

5. Acceptable Results:

- a. The humidifier control valve is closed and humidifier is non-operational above 30 percent RH and control valve modulates open and relative humidity level is maintained when return air is below 30 percent RH.
- b. High limit humidistat prevents RH higher than setting.
- c. Humidifier valve closes on loss of airflow.

E. Loss of Control Power

1. System/Equipment to be Tested:

- a. 04 00 SA ARU-1, 2, and 3, control system, and associated air distribution and control systems.
2. Functions to be Tested: Fail safe position of control dampers and valves when control power is lost; and return to normal operation once power is restored.
3. Conditions of the Test: Begin the test with all systems operating; disengage control power. Restore power after verification of results on a loss of control power.
4. Acceptable Results: valves and dampers fail to their "safe" positions and return to normal operation upon restoration of power.

F. Loss of Power

1. Equipment to be Tested:

- a. 04 00 SA ARU-1, 2, and 3, control system, and associated air distribution and control systems.
2. Functions to be Tested: Shutdown of the units in an emergency power mode and their return to normal operation once power is restored.
3. Conditions of the Test: Begin the test with all systems operating; disengage normal power, switch to emergency power and then restore normal power.
4. Acceptable Results: Unit cycles off and outdoor air dampers close; and the system returns to power per the specified sequence.

3.13 TOILET/UTILITY EXHAUST AND SUPPLY FANS

A. Loss of Control Power

1. System/Equipment to be Tested:

- a. 04 00 EA EAF-1.
- b. 04 00 OA SAF-1.
- c. 04 02 EA EAF-1, 2, and 3.
- d. 04 03 EA EAF-1, 2, and 3.
- e. 04 10 EA EAF-1.1, 1.2, 1.3, and 1.4.
- f. 04 10 EA EAF-2, 3, 4, 5, 6, 7 and 8.
- g. Control system for all of the above, air distribution and associated control systems.

2. Functions to be Tested: Operation of fans when control power is lost and return to normal operation once power is restored.
3. Conditions of the Test: Begin the test with all systems operating; disengage control power. Restore power after verification of results on a loss of control power.
4. Acceptable Results: Fans operate per the specifications.

B. Loss of Power

1. System/Equipment to be Tested:
 - a. 04 00 EA EAF-1.
 - b. 04 00 OA SAF-1.
 - c. 04 02 EA EAF-1, 2, and 3.
 - d. 04 03 EA EAF-1, 2, and 3.
 - e. 04 10 EA EAF-1.1, 1.2, 1.3, and 1.4.
 - f. 04 10 EA EAF-2, 3, 4, 5, 6, 7 and 8.
 - g. Control system for all of the above, air distribution and associated control systems.
2. Functions to be Tested: Fan shutdown in an emergency power mode and their return to operation once power is restored.
3. Conditions of the Test: Begin the test with all systems operating; disengage power, switch to emergency power and then restore normal power.
4. Acceptable Results: Fans return to operation per the specifications.

3.14 HEATING HOT WATER LOOP

A. System/Equipment to be Tested

1. Heating Water Pumps 04 03 HW PMP-1 and 04 03 HW PMP-2.
2. Associated controls.

B. Functions to be Tested

1. Pump sequencing upon failure of lead pump.
2. Pressure and temperature monitoring.
3. Loss of Control Power: Fail safe position of valves when control power is lost, and return to normal operation once power is restored.

C. Conditions of the Test

1. With 04 03 HW PMP-1 operating as the lead pump, open the lead pump electrical disconnect. Repeat test with 04 03 HW PMP-2 operating as the lead pump.
2. Alarm Conditions, Demonstrate
 - a. Failure of the lead pump.
 - b. Failure to maintain water temperature within 2 degrees F of setpoint.
3. Loss of Control Power: Begin the test with all systems operating with a 50 percent load on system, disengage control power. Restore power after verification of results on a loss of control power.

D. Acceptable Results

1. 04 03 HW PMP-1 operates as the lead pump. Failure of 04 03 HW PMP-1 to operate results in 04 03 HW PMP-2 to automatically assume the lead pump position.
2. Same as above only roles of 04 03 HW PMP-1 and 04 03 HW PMP-2 are reversed.
3. All control valves, temperature sensors and pressure sensors' function per design parameters. DDC accurately reads (plus or minus 0.5 percent of independently measured reading) each monitoring point over full range of test. Verify with print out for each monitoring point at each 10 percent increment.
4. Loss of Control Power: Valves fail to their "safe" positions. Once power is restored, automatic control resumes and all control functions required by the sequence of operations are verified.

3.15 CHILLED WATER SYSTEM

A. Chiller Status and Failure

1. Equipment to be Tested: Chillers, chiller control panels, other associated HVAC controls.
 - a. 04 03 CH CHL-1, 2 and 3.
2. Function to be Tested: HVAC controls response to chiller trouble signal from chiller control panel.
 - a. Upon shutdown of a chiller due to internal controls, verify that trouble status is indicated by initiation of alarm by HVAC controls.
 - b. Upon shutdown of a chiller verify that HVAC controls start the next chiller in sequence.
3. Conditions of Test: Interrupt operation of lead chiller. Test each chiller as if it were the lead chiller.
4. Acceptable Results: Next scheduled chiller starts automatically and startup moves on through the remaining chillers automatically.

B. Chiller start command and sequencing response

1. Equipment to be Tested: Chillers, chiller control panels, chilled water pumps, condenser water pumps, and associated HVAC controls.
 - a. Chillers
 - 1) 04 03 CH CHL-1, 2 and 3.
 - b. Chilled Water Pumps
 - 1) 04 03 CH PMP-1, 2, and 3.
 - 2) 04 03 CH PMP-3
 - c. Condenser Water Pumps
 - 1) 04 03 CW PMP-1, 2 and 3.

2. Function to be Tested: Response of system components to a start command from the HVAC system.
3. Conditions of Test: Upon a start command from the HVAC control system, verify that the following events occur in sequence:
 - a. Chiller control sequence is initiated by the DDC system; each chiller is controlled by its own internal control package, which adjusts capacity and maintains the discharge water temperature.
 - b. Verify the following incremental chiller stages:
 - 1) Stage 1: Chiller 04 03 CH CHL-1 on
 - 2) Stage 2: Chiller 04 03 CH CHL-2 on
 - 3) Stage 3: Chiller 04 03 CH CHL-1 & 04 03 CH CHL-2 on
 - 4) Stage 4: Chiller 04 03 CH CHL-1 off, 04 03 CH CHL-2 & 04 03 CH CHL-3 on
 - c. Verify associated chilled water pumps and condenser water pumps are interlocked.
 - d. Chiller and associated pumps start. Demonstrate a 15- minute time lag between stages.
 - e. Demonstrate when chilled water temperature is not maintained at 42 degrees F, (chilled water temperature increasing), the next stage of chiller capacity is initiated. Demonstrate this condition for each stage of loading, for all chillers, from the first stage of cooling (chiller 04 03 CH CHL-1 in a minimally loaded condition, to the final stage, 04 03 CH CHL-1, and 04 03 CH CHL-2 all running and fully loaded).
 - f. Demonstrate when chilled water load decreases, the next lower stage system capacity is initiated. Operate for the following criteria:
 - g. When the temperature difference between process load and return decreases to 5 degrees F, the next smaller chiller stage is initiated, (except to the lowest stage which is minimal).
 - h. Verify the following alarm conditions:
 - 1) For chilled system:
 - a) Alarm is initiated when chilled water temperature rises to 44 degrees F.
 - b) Alarm is initiated when chilled water temperature drops to 40 degrees F.
 - 2) For individual chillers:
 - a) Alarm is initiated when chilled water temperature rises to 44 degrees F.
 - b) Alarm is initiated when chilled water temperature drops to 40 degrees F.
 - c) The chiller in alarm shall cycle off. The next staged chiller shall cycle on.
 - 3) Acceptable Results:
 - a) Chillers start and stop automatically.
 - b) Chillers stage up and down automatically based on system demand.
 - c) Lag times between starting and stopping of individual chillers are established.
 - d) Alarm conditions are verified for chilled water system and each chiller.

C. Pump Control Sequence

1. Equipment to be tested
 - a. Chilled Water Pumps
 - 1) 04 03 CH PMP-1, 2, and 3.
 - b. Condenser Water Pumps
 - 1) 04 03 CW PMP-1, 2, and 3.
 2. Function to be Tested: Response of pump operation from HVAC control system.
 3. Conditions of Test: Upon a command from the HVAC control system, verify the following events occur in sequence:
 - a. Verify pump interlocks are established between chilled water pumps and condenser water pumps.
 - b. For each chiller, 04 03 CH CHL-1, 04 03 CH CHL-2, and 04 03 CH CHL-3 verify that chiller will not start until flow has been proven by differential pressure switch associated with each chiller.
 - c. Verify for each chiller that if a no flow condition is sensed when chiller is supposed to be on, an alarm condition is printed out at the printer. Verify all pump motors will immediately restart after a power interruption is restored.
 - d. Loss of Power: Begin the test with pumps operating, disengage power, switch to emergency power and then restore normal power.
 - e. Emergency Power: Pumps designated to run on emergency power shall be tested and verified that they maintain same control and operating functions as if they were on normal power.
 4. Acceptable Results:
 - a. Condenser water pumps start with respective chilled water pump.
 - b. Chillers will not start until respective flows have been proven.
 - c. Alarm is received by the DDC system if a no flow condition exists when pump is supposed to be on.
 - d. All pump motors start as programmed by the DDC system after a power interruption is restored. Maximum restart shall not exceed 6 minutes.
 - e. All systems required to function on emergency power operate properly.
- D. Condenser Water Control
1. Equipment to be Tested
 - a. Cooling Towers
 - 1) 04 10 CW CTR-1, 2, and 3.
 - b. Condenser Water Pumps:
 - 1) 04 03 CW PMP-1, 2, and 3.
 - c. Chemical Feeders.

- d. Heat Trace.
- 2. Function to be Tested: Condenser Water System and its response in support of the Chilled Water System.
- 3. Conditions of Test
 - a. Cooling Towers: Verify the following sequence: 04 10 CW CTR-1 operates as the lead tower.
 - b. Cooling Towers 04 10 CW CTR-1, 04 10 CW CTR-2, and 04 10 CW CTR-3 modulate as follows:
 - 1) Condenser water supply temperature rises to 85 degrees F, 04 10 CW CTR-2 cycles on.
 - a) If after 15 minutes condenser water temperature has not dropped to 86 degrees F, 04 10 CW CTR-1 Fan cycles on to low speed and modulates up to high speed through variable frequency motor controller.
 - b) If after 15 minutes condenser water temperature has not dropped to 86 degrees F, 04 10 CW CTR-2 cycles on.
 - c) If after 15 minutes condenser water temperature has not dropped to 86 degrees F, 04 10 CW CTR-2 fan cycles on to low speed and 04 10 CW CTR-1's fan reduces to low speed and both fans modulate up to high speed in unison through their respective variable frequency motor controllers.
 - d) When the entering condenser water temperature drops below 83 degrees F, the reverse sequence shall occur. Verify a 15-minute lag between each stage.
 - c. Repeat the above four tests with 04 10 CW CTR-2 operating as the lead tower.
 - d. Repeat the above four tests with 04 10 CW CTR-3 operating as the lead tower.
 - e. Simulate the following tests independently:
 - 1) Temperature rise to 88 degrees F and a temperature drop to 80 degrees F in:
 - a) 04 10 CW CTR-1, 2, and 3.
 - 2) Observe an alarm condition printed out at the printer for each case.
- 4. Chemical Feeders
 - a. System/Equipment to be Tested: Chemical feed pumps.
 - b. Functions to be Tested: Controller's response to water treatment needs.
 - c. Conditions of Test: Operation of controller to meter, inject chemicals, and alarm based on water's conductivity, biocide count and acidity.
 - d. Acceptable Results: System operates in response to chemical makeup needs of water.
 - 1) Alarm of chemical feed solenoid valve failure.
- 5. Heat Tape
 - a. System/Equipment to be Tested: Heat tape freeze protection.

- b. Function to be Tested: Heat tape response to a freeze condition.
- c. Conditions of Test
 - 1) Verify installation of heat tape on the following systems:
 - a) Cooling tower spray water piping.
 - b) Cooling tower makeup water piping.
 - c) Cooling tower spray pump casing.
 - 2) Simulate for two independent locations on each of the three systems a condition, which verifies by means of electrical and thermal metering the following:
 - a) Maintain a minimum water temperature in the pipe of 40 degrees F with ambient air conditions of 0 degrees F.
 - b) Demonstrate a localized freezing condition on a small portion of each of the three systems and verify that the self-regulating feature of the heat trace tape is functioning.
- d. Acceptable Results: The heat trace tape self regulates to maintain a minimum 40 degrees F water temperature in the pie with ambient air conditions at 0 degrees F.

3.16 ELECTRICAL/MECHANICAL ROOM SUPPLY FANS

A. Temperature Control

- 1. Equipment to be Tested: Ventilation makeup air fans and associated exhaust fans, and their associated air distribution and control systems.
- 2. Functions to be Tested: Activation of fans and opening of outdoor and exhaust air dampers in order to maintain space temperature setpoint.
- 3. Conditions of the Test: Prior to beginning the test, each space shall be heated to 92 degrees F, the outdoor air temperature shall be 60 degrees F or less. Monitor and record fan operating and space temperature for one entire cycle, including cooling to 70 degrees F and then rewarming to 90 degrees F. Provide heat source as necessary.
- 4. Acceptable Results: Dampers and fans cycle to control space temperature, plus or minus 2 degrees F, per the control sequences, confirm alarm condition.

B. Supply/Exhaust Fan Interlock

- 1. Equipment to be Tested: Ventilation make-up air fans and associated exhaust fans, and their associated air distribution and control systems.
- 2. Functions to be Tested: Confirm interlock function between ventilation makeup air fans and their associated exhaust fans.
- 3. Conditions of the Test: Begin the test with all the associated fans for the system (as described on the control diagrams) "OFF." Turn on the ventilation makeup air fan. Repeat test for each fan.
- 4. Acceptable Results: The unit confirms the interlock function when each of the ventilation makeup air fans is individually turned "ON" and "OFF."

C. Loss of Control Power

1. System/Equipment to be Tested: Ventilation make-up air fans and associated exhaust fans, and their associated air distribution and control systems.
2. Functions to be Tested: Fail safe position of control dampers when control power is lost, and to the return to "normal" operation once power is restored.
3. Conditions of the Test: Begin the test with all systems operating; disengage control power. Restore power after verification of the results on a loss of control power.
4. Acceptable Results: Dampers fail to their "safe" positions and return to normal operation upon restoration of power.

D. Loss of Power

1. System/Equipment to be Tested: Ventilation make-up air fans and associated exhaust fans, and their associated air distribution and control systems. This test may be performed in conjunction with tests performed in other sections of Division 23.
2. Functions to be Tested: Shutdown of the fans in an emergency power mode and their return to normal operation once power is restored.
3. Conditions of the Test: Begin test with all systems operating; disengage power, switch to emergency power and then restore normal power.
4. Acceptable Results: Units cycle off and are returned to power per the specified sequence.

3.17 ENVIRONMENTAL CONTROL SYSTEMS

- A. Systems/Equipment to be Tested: Mechanical and Electrical environmental control systems.
- B. Functions to be Tested: It is recognized that many of the control functions required of the Mechanical and Electrical systems will be tested and verified in other sections of Division 23. It is not the intent of this section to duplicate previously tested, verified and approved control functions. It is the intent of this section, however, to complete the process of testing and verifying all of the environmental control system functions not included under other sections of Division 23, and to test the building control functions as they relate and interact with each other.
- C. Conditions of Test:
1. Operate all of the buildings' environmental control system functions as called for by the contract drawings and specification, Divisions 23, 25, and 26, both individually and interactively.
 2. Create the following electrical conditions
 - a. Normal power on to building.
 - b. Normal power off; emergency power on to building.
 - c. Normal power restored to building.
- D. Acceptable Results: All environmental control functions operate successfully, (individually and interactively), as described by the contract documents.

3.18 SYSTEM DATA

- A. Report: The certified report shall include for each air handling unit, chilled water system, and heating water system the data listed below.

B. Equipment.

1. Installation Data:

- a. Equipment schedule identification
- b. Manufacturer and model number
- c. All nameplate data
- d. Type/size
- e. Arrangement and discharge
- f. Motor HP , voltage, phase, cycles, and full load amps
- g. Location in the building
- h. Motor and fan sheave size, fan class manufacturer and model number
- i. Motor and pump impeller size, manufacture and model number
- j. Number of belts, belt size, manufacturer and model number

2. Design Data: Data listed in schedules on drawings and in the specifications.

3. Recorded (Test) Data:

- a. Date and time of readings and name of technician.
- b. CFM , measured by traverse at or near the fan.
- c. GPM , measured by flow reading at or near the pump.
- d. Static pressure readings across each component in the fan casing or plenum (each coil, filter bank, control damper, louver, etc.)
- e. Total pressure readings, where appropriate.
- f. RPM
- g. Motor operating amps and volts (for each leg).
- h. Motor operating BHP .
- i. Fan curve with operating point.
- j. Pump curve with operating point.
- k. Fuse and starter heater sizes.
- l. Damper positions (outdoor air, return air, etc.).
- m. Verify that sheave alignment and belt tension have been checked and adjusted.
- n. Variable frequency motor controller operation test observations and static pressure sensor set point.
- o. Economizer damper minimum position test observations and data.

END OF SECTION 23 08 16

SECTION 23 20 00 - BUILDING HVAC SERVICES PIPING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Piping, fittings, joints, valves, supports, and flow measurement systems for Division 23.
- B. Instrumentation requirements associated with controls, not limited to temperature transmitters, gauge pressure transmitters, differential pressure transmitters, continuous level transmitters, electrically actuated valves, electric valve actuators, shall be per specification sections 25 00 00 70 and 25 00 10 70, "Instrumentation".

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound, and Vibration Control
- D. Section 23 05 53 – Identification for mechanical Piping ductwork and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 07 00 - HVAC Insulation
- G. Section 23 08 16 - Commissioning of HVAC Systems
- H. Section 23 21 16 – Hydronic Piping Specialties
- I. Section 23 21 23 - Hydronic Pumps
- J. Section 23 22 16 – Steam and Condensate Heating Piping Specialties
- K. Section 23 25 00 - Water Treatment Systems
- L. Section 23 25 33 – HVAC Water Filtration Equipment
- M. Section 23 57 00 – Heat Exchangers
- N. Section 23 64 16 - Liquid Water Chillers
- O. Section 23 65 13 – Packaged Cooling Towers
- P. Section 23 73 13 – Indoor Basic Air Handling Units
- Q. Section 23 73 16 – Air Rotation Units

- R. Section 23 73 43 – Outdoor Custom Air Handling Units
- S. Section 23 81 26 – Split System Air Conditioners
- T. Section 23 82 39 – Unit Heaters
- U. Section 25 00 10 – Chiller Plant Control System
- V. Section 25 00 20 - Hot Water Skid Control System
- W. Section 25 00 20 – Air Handlers Control System

1.3 QUALITY ASSURANCE

- A. Valves shall conform to ASME Boiler and Pressure Vessel Code Specifications where indicated or required by state or local code.
- B. Comply with ASME B31.9, "Building Services Piping" for materials, products, and installation for steam and steam condensate piping.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Statement of piping and fitting material, and type of joint to be used for each piping system.
- C. Manufacturer's technical product data, installation instructions and description of accessories for each type to be used and system designation:
 - 1. Valves
 - 2. Pipe Supports
 - 3. Insulation Protection
 - 4. Flow Measurement Systems
 - 5. Thermometers and Test Wells
 - 6. Pressure Gages and Test Connections
 - 7. Coil Hook-up Assemblies
- D. Test reports for refrigeration and fire suppression piping.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Workmanship:

1. Cut pipes accurately to measurements established at structure.
2. Install without springing or forcing.
3. Clear windows, doors, and other openings.
4. Permit expansion and contraction without misalignment or damage.
5. During construction, close openings in piping and equipment to keep out foreign matter and to prevent leakage.
6. Piping shall be concealed unless otherwise indicated.
7. Provide offsets required to avoid structural or other interference without extra cost to the Government.

B. Drainage:

1. Grade to low points.
2. Provide hose end drain valves at bottom of risers, low points, and where indicated.

C. Access: All valves, unions, flanges, expansion joints, and flow measurement devices shall be installed in accessible locations.

PART 2 PRODUCTS

2.1 FITTINGS AND ACCESSORIES

- A. Welding Branch Fittings: Welding tees, Bonney Weldolets, or Thredolets, Allied Piping Products Type 1 fittings.
- B. Reducers: Reducing fittings, eccentric type where required to prevent pocketing of air and water.
- C. Unions, Flanges, Mechanical Couplings, and Gaskets:
1. Suitable for intended duty and rated for not less than system test pressure.
 2. Dielectric (insulating) type in water piping systems, suitable for intended service.

2.2 PIPE, FITTINGS AND JOINTS

A. Pipe:

TYPE	REFERENCE
E	Black Steel Pipe: ASTM A53 Grade B, ERW or seamless; or ASTM A106 Grade B seamless. Sizes through 10 inches, standard weight, 12 inches and larger 3/8-inch wall.
L	Seamless Copper Water Tube: ASTM B88, Type "L" hard temper; ASTM B280 for Type ACR.
A1	Polypropylene Pipe and Fittings: Schedule 80 pipe manufactured from virgin unpigmented pipe grade polypropylene, pressure rated for 80 psi at 40 degrees C.

B. Fittings:

TYPE	REFERENCE
------	-----------

TYPE	REFERENCE
BB	Wrought Copper Solder Joint Fittings: ANSI/ASME B16.22.
FF	Black Cast Iron Screwed Fittings: 125 psi steam, 175 psi water, ANSI/ASME B16.4.
HH	Black Cast Iron Screwed Fittings: 250 psi, ANSI/ASME B16.4.
MM	Steel Butt-Welding Fittings: ANSI/ASME B16.9.
UU	Polypropylene Schedule 80 socket weld fittings with tapered sockets, manufactured from virgin unpigmented pipe grade polypropylene, pressure rated for 80 psi at 40 degrees C.

C. Joints:

TYPE	REFERENCE
1	Threaded-American Standard for Pipe Threads: ANSI B1.20.
2	Welded-Engineering Standards of the Mechanical Contractor Association of America, Inc., Part VII, Standard Procedure Specifications Nos. 1 and 2.
7	Soldered: ASTM B32; Tin-antimony, 95-5, tin silver 96-4, or tin silver 94-6.
9	Brazed-Silver Alloy Brazing equal to Sil-Fos and Easy-Flow by Handy and Harman.
12	Heat Fused: In accordance with manufacturer's recommendations.

2.3 VALVES

- A. Manufacturer's Tests: Each valve shall be given shell and seat tests by the manufacturer and shall carry a permanently affixed indication that tests have been successfully completed.
- B. ASME Boiler Code Compliance: Provide valves, that conform to ASME Boiler Code Specifications, where indicated, or where required by state or local code.
- C. Combination Balancing and Shutoff Valve:
- Multi-turn adjustment range equal to Armstrong Circuit Balancing Valve Model CBV series.
 - Pressure/temperature ports.
 - Positive shutoff.
 - Memory setting feature.
 - Micrometer-type handwheel adjustment with readable settings.
 - Valve selection shall be sized by flow requirements and not line size.
 - Manufacturers: Armstrong, Danfoss, Grinnell, Nibco, Red-White Valve Co.
- D. Non-lubricated, Eccentric Plug Valves:
- Materials and Construction: Semi-steel body, high temperature synthetic faced plugs (suitable for 250 degrees F continuous duty). Nickel alloy seat 2-1/2-inch and larger. Self-lubricating bearings. Valves shall be packable under pressure with valve in open position.

2. Pressure Rating: 150 psi body to 12-inch inclusive, bubble tight shut off for 150 psi differential in either direction.
 3. Actuators: Three inches and smaller, non-removable levers. Four to 6-inch removable lever. Eight inches and larger, handwheel actuators with enclosed worm gear or Scotch yoke. Actuators shall have position indicators and adjustable maximum opening stops.
 4. Manufacturer: DeZurik.
- E. Butterfly Valves:
1. Material and Construction: Cast iron full lug wafer body for flanged connection with alignment boltholes or guides. Resilient, mechanically retained, field replaceable seat of Nordel, EPDM or approved elastomer, suitable for continuous duty at 250 degrees F. Stainless steel disc. Stainless steel shaft with teflon self-lubricating bearings, "O" ring or chevron stem seals for continuous duty at 250 degrees F. Two-inch extension neck on valves for insulating piping. Thrust bearings or vented shaft end to support or neutralize hydraulic or external axial shaft loads.
 2. Pressure Ratings: 150-psi body; bubble tight shut off for 150-psi differential in either direction. Bubble-tight dead-end service. Factory test each valve for operation, leakage, and pressure in accordance with AWWA Standard C504.
 3. Actuator: For valves under 8 inches, lever with locking trigger with notched quadrant. For valves 8 inches and above, enclosed, self-locking worm gear or worm screw with hand wheel. Both types equipped with adjustable maximum opening travel stops.
 4. Installation: Use welding neck or socket type companion flanges. Valves may be connected directly to flanges used as unions to permit equipment, control or check valve removal if equipped with tapped lugs or integral double flanges and secured so that valve remains in service when equipment is removed.
 5. Manufacturers: Stockham, Fisher, NIBCO, Milwaukee, Hammond, Jamesbury, Centerline, Grinnell, Keystone, Continental, Bray, DeZurik, TRW Mission, Crane-Monark, Demco; Victaulic Vic-300 in compatible piping systems.
- F. Drain Valves: Hose end ball valve with cap and chain equal to NIBCO Fig. T-585-70-HC ball with American Standard Garden Hose type threads. Drain valves on potable water systems shall include a vacuum breaker hose connection.
- G. Silent Check Valves: Equivalent to Mueller Steam Company figure numbers as follows:
1. Two-inch and Larger:
 - a. Figure 105M, globe type, flanged. Body: Cast iron, ASTM QA126, Class B or carbon steel ASTM A216, Class WCB.
 2. One-half to 1-1/2-inch: Figure 303, threaded. Body: Bronze, ASTM B62.
 3. Seat Disc, Spring:
 - a. Stainless steel springs and guides with stainless steel or bronze ASTM B62 disc and seat.
 4. Manufacturers: Milwaukee, NIBCO, Williams-Hager, APCO Valve and Primer Co., Hammond, Mueller Steam, Miller Valve Co.; Steamflo.
- H. Gate, Globe, and Check Valves:

1. Gate and globe valves designed for repacking under pressure when fully opened, and equipped with packing suitable for the intended service. When the valve is fully opened, the back seat shall protect the packing and the stem threads from the fluid. Each gate and globe valve shall have a gland follower.
 2. Bronze valves with the basic saturated steam rating of 125 psi or 150 psi shall have pressure containing parts of a material having at least the physical properties of ASTM Specification B-62. Metallic seated bronze globe, angle, check and gate valves with a basic steam rating of 200 or 300 psi having pressure containing parts of material conforming to ASTM B-61, for temperatures to 550 degrees F.
 3. Pressure containing parts of iron body valves shall be of material conforming to ASTM A-126 Grade B. If the wedge in OS&Y gate valves is fastened to the stem by threads, it shall be secured by a nickel alloy or monel pin.
 4. Face-to-face and end-to-end dimensions of iron body valves to conform to ASME B16.1. Design, workmanship, materials, and testing to conform to MSS-SP-70, MSS-SP-71, and MSS-SP-85 (Manufacturers Standardization Society of the Valve and Fitting Industry).
 5. Solid wedge type gate valves, designed and manufactured in such a way that seating surfaces are prevented from contacting until near the point of closure.
 6. Handwheels of ASTM A47 malleable iron or ASTM A126, Class A or B iron.
 7. Manufacturers: Unless otherwise indicated, Crane, Grinnell, Hammond, Kennedy, Milwaukee, NIBCO, Powell or Stockham equal to NIBCO, Crane or other listed manufacturer figure numbers as noted in Schedule of Services.
- I. Ball Valves:
1. Ball valves shall have stem extension to place handle outside the insulation when valve is to be installed in insulated piping.
 2. Type A: Bronze or brass body, stainless steel ball and stem, reinforced Teflon seats and seals, full port size, threaded or solder end as required scheduled through 2-inch size and acceptable for 2-1/2-inch size if valve is full port. Valve shall be three-piece or shall have removable cartridge to permit complete access removal, and replacement of components without removal of the valve from the piping system and without disturbing the piping system. NIBCO 595-Y-66.
 3. Type B: Same as Type A except with stainless steel body, ball, and stem. NIBCO 595-S6-R-66.
 4. Type C: Stainless steel body, ball and stem, reinforced teflon seats and seals, reduced port, flanged end. NIBCO F510-S6-R-66.
 5. Manufacturers: Unless otherwise indicated, Apollo, Contromatic, Crane, Dynaquip, Fairbanks, Hammond, ITT Grinnell, Jamesbury, MarPac, Milwaukee, NIBCO, Powell, Watts, Webstone, Worcester for the types listed in Schedule of Services.
- J. Schedule of Services: Unless otherwise indicated, valves are for aboveground service. Size range indicated is size of pipe where valves are required. Valves shall be pipe size or larger. Unless otherwise indicated FIGURE NO. indicates NIBCO number.

CONDENSER, CHILLED WATER (125 PSIG AND LESS) AND, CONDENSER WATER DRAINS, COOLING TOWER FILTRATION SYSTEM				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Butterfly	4-inch and Larger	-	-	See Specifications
Ball	2-1/2 & 3-inch	Use 3-inch Valve for Both Pipe Sizes	-	Type C

CONDENSER, CHILLED WATER (125 PSIG AND LESS) AND, CONDENSER WATER DRAINS, COOLING TOWER FILTRATION SYSTEM				
Ball	2-inch and Smaller	-	-	Type A
Globe	2-1/2-10-inch	-	IBBM, OS&Y, FLG	F-718-B
Globe	2-inch and Smaller	-	Soldered End	S-235-Y
Check	2-1/2-12-inch	-	IBBM, FLG	F-918-B
Check	2-inch and Smaller	-	Soldered End	S-433-B

STEAM SUPPLY AND STEAM CONDENSATE RETURN PRESSURE 125 PSIG AND LESS				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Gate	2-1/2 - 16-inch	Steam Supply Over 70 psig Nominal Pressure - Valves: 4-inch and Larger shall have Factory Installed Bypass with Globe Valve	IBBM, OS&Y, FLG	F-617-O
Gate	2-inch and Smaller	-	-	T-134
Ball	2-1/2-4-inch	Steam Supply and Condensate Return: Minimum size Valve 3-inch	-	Type C
Ball	2-inch and Smaller	-	-	Type B
Globe	2-1/2-10-inch	-	IBBM, OS&Y, FLG	F-718-B
Globe	2-inch and Smaller	-	-	T-276-AP
Check	2-1/2-12-inch	-	IBBM, FLG	F-918-B
Check	2-inch and Smaller	-	-	T-433-B

HOT WATER HEATING				
TYPE	SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
Butterfly	4-inch and Larger	-	-	See Specifications
Ball	2-1/2 and 3-inch	Use 3-inch Valve for Both Pipe Sizes	-	Type C
Ball	2-inch and Smaller	-	-	Type A
Globe	2-1/2-inch and Larger	-	IBBM, OS&Y, FLG	F-718-B
Globe	2-inch and Smaller	-	Soldered End	S-235-Y
Check	2-1/2-inch and Larger	-	IBBM, FLG	F-918-B
Check	2-inch and Smaller	-	Soldered End	S-433-B

REFRIGERANT			
SIZE RANGE	SPECIFIC REQUIREMENTS	STYLE	FIGURE NO.
1/4-1-1/8-inch ODS	-	-	Henry 626
1-3/8 - 4-3/8-inch ODS	-	-	Henry 203

K. Automatic Water Flow Control Valves:

1. Factory calibrated to maintain constant flow (plus or minus five percent) over system pressure fluctuations of at least 10 times the minimum required for control. Provide standard pressure taps and four sets of capacity charts. Valve size shall be as indicated on the drawings and be one of the following designs:
 - a. Gray iron (ASTM A126) or brass body rated 175 psig at 200 degrees F, with stainless steel piston and spring that is easily removable for inspection or replacement.
 - b. Brass or ferrous body designed for 300 psig service at 250 degrees F, with corrosion resistant, tamper proof, self-cleaning piston/spring assembly that is easily removable for inspection or replacement.
 - c. Combination assemblies containing ball type shut-off valves, unions, flow regulators, strainers with blowdown valves and pressure/temperature ports shall be acceptable.
 - d. Valve shall be capable of passing a 1-inch solid.
 - e. Valve shall be permanently marked to show direction of flow, shall have a body tag to indicate model number and flow rate.
 - f. Provide certified independent laboratory tests verifying accuracy of performance.
 - g. Warranted by the manufacturer for five years from date of sale.
 - h. Provide a readout kit including flow meter, probes, hoses, flow charts and carrying case.

L. Manufacturer: Griswold.

2.4 PIPE SUPPORTS

- A. General: Supports shall be plastic coated for plastic pipe, copper plated for copper tubing and brass pipe, galvanized for uninsulated galvanized steel pipe, and black steel for other metallic piping. Outdoor supports shall be copper plated for copper tubing and brass piping, and galvanized for all other piping.
- B. Horizontal Piping
 1. Clevis Hangers: Adjustable wrought steel clevis hangers.
 2. Roll Hangers: Adjustable steel yoke roll hangers for chilled water, hot water heating, and steam piping larger than 2-1/2-inch diameter.
 3. Under Supports:
 - a. Where no provision for expansion and contraction is required:
 - 1) Floor Mounted: Adjustable cast iron saddle with floor flanges secured to floor and pipe nipple of suitable length.
 - 2) Trapeze or Metal Frame Mounted: Inverted U bolts with saddle supports for insulated pipe.
 - 3) Wall Mounted: Steel J hooks for pipes 3-inch and smaller; welded steel brackets for larger pipes with hanger or support same as for trapeze.
 - b. Where provision for expansion and contraction is required provide adjustable pipe roller and base secured to support. For floor mounting provide concrete pier under base; for wall mounting provide welded steel bracket.

4. Metal Frame Supports:
- Provide as required vertical and horizontal 12 gage galvanized steel channels and fittings bolted together to form a multiple pipe rack secured to the building structure with post bases and brackets. Equal to Grinnell Power-Struct, ASTM A-446, Grade A, hot dipped zinc coated steel with safety end enclosures.
 - Manufacturers: B-Line, Steel City, Unistrut, Grinnell.
5. Lateral Movement: Provide dual movement type rollers where undersupports are required and where expansion and contraction will cause lateral movement.
- C. Vertical Piping:
- Steel extension pipe clamps for piping not subject to vertical movement by expansion or contraction.
 - Variable spring supports for piping subject to vertical movement by expansion or contraction.
 - Base fitting set on concrete, brick pier or pipe stand where necessary at bottom of piping risers.
- D. Insulation Protection:
- Saddle: 18 gage galvanized sheet metal.
 - Roller Saddle: Curved steel with protecting lugs or turned up edges.
 - Thermal Shield: 360 degrees insert of waterproofed calcium silicate insulation with 100 psi compressive strength encased in galvanized steel jacket equivalent to Pipe Shields, Inc. Model A2000 (CS-CW Series) for chilled waterlines and Model A1000 (CS) for other insulated lines. Use Model A4000 (CSX-CW) and Model A3000 (CSX) wherever pipe hanger span exceeds 10 feet and for pipe roller applications. Insert shall be same thickness as adjoining pipe insulation. Shield length and minimum sheet metal gages as indicated. Insulation insert shall extend 1-inch beyond sheet metal shield on chilled water piping. Where pipe hanger spacing exceeds 10 feet and where pipe rollers are used, provide double layer shield on bearing surface.
 - Manufacturers: B-Line, Pipe Shields, Inc., Value Engineered Products.

PIPE SIZE IN INCHES	SHIELD LENGTH IN INCHES	MINIMUM GAGE
1/2 – 1-1/2	4	26
2 – 6	6	20
8 – 10	9	16

2.5 EQUIPMENT RAILS

- A. Furnish equipment rails equal to Roof Products and Systems Corporation, Model ER-4B, where indicated on the drawings.
- B. Equipment rails shall be manufactured of 18 gage galvanized steel, fully mitered and welded corners, 3-inch cant. Equipment rails shall be internally reinforced with integral baseplate and factory installed 2 by 8-inch wood nailer. Height shall be 18 inches above finished roof.
- C. Manufacturers: Pate, Roof Products and Systems Corp.

2.6 PIPE PEDESTALS

- A. Furnish pipe mounting pedestals equal to Roof Products and System Corp., Model ER-4A, where indicated on the drawings. The pipe mounting pedestal shall include equipment rail, sized for the number of pipes and specified in this section, as associated galvanized steel slide channel attached to "U" shaped mounting brackets and secured to side of equipment rails with lag bolts supplied. The pipe roller assembly shall have galvanized 18-inch-long continuous threaded rod to give 12-inch vertical adjustment, galvanized removable pipe retainer bracket for 12-inch horizontal adjustment. All pipe mounting pedestals shall be factory assembled.
- B. Manufacturers: Caddy Pyramid, Pate, Roof Products and Systems Corporation.

2.7 PIPE PORTALS

- A. Furnish pipe portals equal to Roof Products and Systems Corporation, where indicated on the drawings. The pipe portal shall include an 18-gage galvanized steel roof curb, Model RC-4A, with integral baseplate, continuously welded corner seams, factory-installed wood nailer and 1-1/2-inch, 3-pound density rigid fiberglass insulation.
- B. The pipe portal shall be provided with a laminated acrylic-coated ABS plastic curb cover with prepunched holes and molded sealing ring on an 8-inch collared opening, and an EPDM compression molded cap with stainless steel snaplock clamps.
- C. Curb covers shall be resistant to ozone and ultraviolet rays and shall have a serviceable temperature range of minus 40 to 350 degrees F. The protective rubber caps shall have a serviceable temperature range of minus 60 to 250 degrees F and shall be resistant to ozone and ultraviolet rays. The conical shaped steps of the nipple shall provide a weatherproof seal around the penetration. The stainless steel snaplock clamps shall provide added protection to guarantee the seal.
- D. Manufacturers: Pate, Roof Products and Systems Corporation.

2.8 FLOW MEASUREMENT SYSTEMS

- A. Flow Meters shall be per specification sections 25 00 00 70, "Instrumentation".

2.9 THERMOMETERS AND TEST WELLS

- A. Types:
 - 1. Direct Mounting: 5-inch dial, externally calibrated, standard industrial bimetal, with stainless steel stems and cases equal to Weston Models 4503 and 4513. Stem length - minimum, 1/2 depth of pipe; maximum, 24 inches.
 - 2. Where indicating points cannot be conveniently read or temperature correctly sensed, provide organic fluid filled protected capillary tube for remote mounting.
- B. Ranges:
 - 1. For Media Temperatures not Exceeding 100 degrees F: 25 to 125 degrees F.

2. For Media Temperatures above 100 degrees F, but not Exceeding 220 degrees F: 30 to 240 degrees F.

- C. Accessories: Provide with separable brass wells with insulation extension on insulated pipe.
- D. Manufacturers: Ashcroft, Marsh, Marshalltown, Moeller, Taylor, Tel-Tru, Trerice, U.S. Gage, Weiss, Weksler, Weston, Winters.
- E. Test Wells: Thermowells shall be per specification sections 25 00 00 70, "Thermowells"

2.10 PRESSURE GAGES AND TEST CONNECTIONS

- A. Type: General purpose bronze bourdon tube, bronze bushed movement mounted on socket independent of case, 1 percent minimum accuracy at mid-range, 4-1/2-inch white face equal to Ashcroft Catalog No. P2070A.
- B. Ranges: Approximately twice the maximum operating pressure. Provide compound gages wherever negative pressures can occur.
- C. Accessories: Provide gages with Trerice No. 735 or 740 valve suitable for intended pressure, temperature and service and, for steam, brass siphon tubes. For pump and compressor suction and discharge, provide porous core snubbers.
- D. Manufacturers: Ashcroft, Marsh, Marshalltown, Moeller, Taylor, Tel-Tru, Trerice, U.S. Gage, Weiss, Weksler, Weston, Winters.
- E. Test Connections: Provide with Trerice No. 735 or 740 gage valves suitable for intended pressure.

2.11 COIL HOOK-UP ASSEMBLIES

- A. Provide valves, strainers, unions, air vents, test ports, thermometers, flow measurement, etc. indicated on drawings for coil connection details.
- B. Components shall meet specifications indicated for these components in this and other sections of the specifications.
- C. Manufacturers: Bell & Gossett, IMI Flow Design, Nexus.

PART 3 EXECUTION

3.1 FITTINGS AND ACCESSORIES

- A. Welding: Make changes in direction and size with welding fittings. Use welded branch fittings in joining a branch to a main. Finish exposed galvanized welds with Galv-Weld.
- B. Brazing: Provide a dry nitrogen purge during brazing operations to prevent oxidation to copper pipe.

- C. Reducers: Use reducing fittings to make changes in pipe sizes.
- D. Unions, Flanges, Mechanical Couplings, and Gaskets
 - 1. Install at each piece of equipment, in bypasses, and long piping runs to permit disassembly for alteration and repairs.
 - 2. Equipment Connections: Provide piping connections which conform to indicated sizes, details, reviewed shop drawings, and printed installation instructions furnished by manufacturer.
 - 3. Dielectric (Insulating) Type: Install in water piping systems where pipes of dissimilar metals are joined and where unions are required by contract documents.
- E. Threads: Remove burrs and ream to full inside diameter.

3.2 PIPE, FITTINGS AND JOINTS

A. Schedule

SYSTEM	PIPE	FITTINGS	JOINTS
Condenser Water, Cooling Tower Equalizer Line			
1. Aboveground	E	MM	2
Steam Supply			
1. 2-1/2-inch and larger	E	MM	2
2. 2-inch and smaller	E	FF	1
Steam Condensate Return: Gravity and Pumped			
1. Aboveground: 2-1/2-inch and larger * Extra Strong Pipe	E*	MM*	2
2. Aboveground: 2-inch and smaller * Extra Strong Pipe	E*	HH	1
Chilled Water			
1. 2-1/2-inch and larger	E	MM	2
2. 2-inch and smaller	L	BB	7
Hot Water Heating			
1. 2-1/2-inch and larger	E	MM	2
2. 2-inch and smaller	L	BB	7
Chiller Relief, Refrigeration Piping * Type ACR	L*	BB	9

3.3 VALVES

- A. Adjust for smooth and easy operation.
- B. Install in locations where valve can easily be adjusted.
- C. Install valves full size of pipe before reducing size to make connection to equipment and controls.
- D. Remove excess solder and other foreign matter from valve interior after installation before operating valve.
- E. Provide chainwheel operators for valves in equipment rooms mounted greater than 7 feet above

floor level. Extend chain to 7 feet 0 inches above floor level.

- F. Cut Off or Stop Service: Gate or ball, as specified, except butterfly valves for condenser, chilled, heating, water service 4 inch and larger. Series 100 DeZurik as specified under "Non-lubricated Plug Valves" may be used in lieu of gate, ball, or butterfly valves.
- G. Throttling or Control Valve Bypass: Globe or non-lubricated plug valves.
- H. Balancing Valves:
 - 1. Three-inch and Smaller: Combination balancing and shutoff valve.
 - 2. Four inches and larger. Non lubricated plug valve.
- I. Silent Check Valves: Install in pump discharge piping.
- J. Set field adjustable flow set point of balancing valves.

3.4 PIPE SUPPORTS

- A. Preparation and Application:
 - 1. Provide supports to maintain required slope and alignment.
 - 2. Secure hangers to rods with double nuts.
 - 3. Make allowance for expansion and contraction.
 - 4. Do not support pipes from ducts or other pipes.
 - 5. Use trapeze hangers for parallel runs of pipe with same slope.
 - 6. Provide bracing to prevent lateral motion of horizontal or vertical piping.
 - 7. Provide supports at or near changes in direction.
 - 8. Do not pierce ducts with hanger rods.
 - 9. Provide strength and rigidity suitable for loads imposed.
 - 10. Support piping so there is no strain on the connection to pumps and other equipment.
 - 11. Support piping using mechanical couplings in accordance with manufacturer's instructions and recommendations.
- B. Horizontal Piping:
 - 1. Adjustment: Provide vertical adjustment of supports for horizontal piping after installation.
 - 2. Maximum Support Spacing:
 - a. Steel Lines: 1-1/2-inch (and smaller, 6 feet; 2-inch and larger, 10 feet.
 - b. Copper Lines: 1-1/2-inch and smaller, 5 feet; 2-inch and larger, 8 feet.
 - c. Cast Iron Soil Pipe: One support at each joint, but not greater than 10 feet.
 - 3. Metal Frame Supports: Space frames in accordance with smallest pipe requirements and design for a maximum deflection of 1/360 of the span.
- C. Vertical Piping:
 - 1. Support vertical lines at locations indicated. Where not indicated, support plastic, copper, and cast-iron soil pipe at every floor, steel pipe at every other floor. Brace plastic piping on maximum 6-foot centers.

2. Where supports are necessary at bottom of risers, provide a base fitting set on either concrete or brick pier or a pipe stand. In lieu of using a base fitting, a hanger at bottom horizontal connection may be used. Locate hanger as close to riser as possible, but permitting sufficient free offset where allowance for expansion and contraction is necessary.

D. Insulation Protection:

1. For chilled water piping, provide saddle for piping 4-inch and smaller. Provide thermal shield for piping larger than 4-inch. Thermal shields for pipes 4-inch (and smaller is optional. Thermal shields for heating hot water piping is optional:
 - a. Saddle: For "Chilled Water Piping," (refer to Section 23 07 00, "Mechanical Insulation" for extent) provide hangers outside of covering. Between hanger and covering, provide sheet metal saddle formed to fit bottom half of the insulation. Minimum side dimension of saddle equal to one-half the insulation circumference.
 - b. Thermal Shield: Provide 3-inch-wide vapor barrier tape or band over butt joints. Where vapor barrier is required, apply a wet coat of vapor barrier lap cement on butt joints before applying tape or band. Coordinate with Section 23 07 00, "HVAC Insulation."

- E. Roller Saddle: Provide where insulated piping other than chilled water lines are supported on rollers. Weld lugs to pipe.

3.5 EQUIPMENT RAILS

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Height to bottom of rails shall be 18 inches above finished roof.

3.6 PIPE PEDESTALS

- A. Install in accordance with manufacturer's instructions and recommendations.

3.7 PIPE PORTALS

- A. Install in accordance with manufacturer's instructions and recommendations.

3.8 FLOW MEASUREMENT SYSTEMS

- A. Locate measuring device in accessible locations with straight section of pipe upstream and downstream as recommended by the manufacturer for good accuracy.
- B. Locate horizontally mounted measuring device pressure taps on side of pipe.
- C. Meters:
 1. Meters shall be electronically connected to the building automation system.
 2. The building automation system shall trend:

- a. The flow, supply water temperature, and return water temperatures of the chilled water system as well as the energy usage.
- b. The flow of the condenser water system.

3.9 THERMOMETERS AND TEST WELLS

- A. Install thermometers at temperature control points (except individual room thermostats); water entering and leaving condensers, chillers, and heat exchangers, and elsewhere as indicated.
- B. Install test wells where indicated on the drawings, located above horizontal position in pipe with 12-inch minimum clearance above well.

3.10 PRESSURE GAGES AND TEST CONNECTIONS

- A. Install pressure gages at pressure control points, pump suction and discharge, cooling tower spray manifold, water entering and leaving heat exchangers and elsewhere as indicated.
- B. Install test connections suitable for intended pressure in piping entering and leaving chillers and condensers and where indicated for testing.

3.11 COIL HOOK-UP ASSEMBLIES

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Install in accordance with coil connection details shown on drawings.

3.12 PIPE TESTING

- A. Preparation and Application:
 - 1. Test piping to prove tightness.
 - 2. Test concealed piping before enclosing.
 - 3. Replace and re-test pipe or fittings broken or damaged under test.
 - 4. Remove or protect from damage items not designed to withstand testing pressure; e.g., control devices, air vents, boilers, and thermostatic trap elements.
 - 5. Advise Contracting Officer's Representative (COR) prior to tests.
- B. Standing Water Test:
 - 1. Plug and test gravity drain piping with water by filling to the top of highest pipe.
 - 2. Test sections of piping separately with a minimum head of 10 feet of water.
 - 3. Apply test to entire water system with temporary standpipe to provide additional 10 feet head on system.
 - 4. Piping shall show no leakage after standing for eight hours.
- C. Pressure Testing:
 - 1. Test pressures shall be 1-1/2 times the system working pressures and a minimum of 100-psi,

- unless otherwise indicated.
2. Test water, steam, and steam condensate piping hydrostatically protecting traps, seals, etc. from excess pressure.
 3. Valves shall be open, but not backseated for packing check. However, it is permissible to test against a closed valve if the test pressure does not exceed the valve pressure rating at test temperature.
 4. Blind flanges, or the equivalent, shall be used instead of valves for dead-end shutoff.
 5. Inspect each joint for leakage while under test.
 6. Apply soapsuds to joints under air pressure test.
 7. Maintain pressure tests for a minimum of four hours.
 8. Perform refrigeration-piping tests in compliance with the American Standard Safety Code for Mechanical Refrigeration, ASA B9.1.
 9. Maintain applicable safety methods while performing tests. These methods shall include but shall not be limited to applying pressure at increments of 25 psi, providing sufficient time to allow the piping to equalize strains, until specified test pressure is attained. The piping system shall be examined only when the pressure in it is not increasing.

END OF SECTION 23 20 00

SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Fluid handling equipment and associated accessories, piping, and air control.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 93 - Testing, Adjusting, and Balancing
- D. Section 23 07 00 - HVAC Insulation
- E. Section 23 08 16 - Commissioning of HVAC System
- F. Section 23 20 00 - Building HVAC Services Piping
- G. Section 23 21 23 - Hydronic Pumps
- H. Section 23 25 33 - HVAC Water Filtration Equipment
- I. Section 23 57 00 – Heat Exchangers
- J. Section 23 64 16 – Liquid Water Chillers
- K. Section 23 65 13 - Packaged Cooling Towers
- L. Section 23 73 13 13 - Indoor Basic Air Handling Units
- M. Section 23 73 16 – Air Rotation Units
- N. Section 23 73 43 - Outdoor Custom Air Handling Units
- O. Section 23 82 39 - Unit Heaters
- P. Section 25 00 00 – Chiller Plant Control System
- Q. Section 25 00 10 – Hot Water Skid Control System

1.3 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX:
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VII, Division 1.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of components:
 - 1. Expansion Tanks
 - 2. Air Separators
 - 3. Pressure Reducing Valves
 - 4. Backflow Preventers
 - 5. Pressure Relief Valves
 - 6. Air Vents
 - 7. Flow Check Valves
 - 8. Strainers
 - 9. Expansion Loops
- C. Operation and Maintenance Data: Include in emergency, operation, and maintenance manuals:
 - 1. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer in the State the project is located responsible for their preparation.
- D. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
- E. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
- F. Alignment Guide Details: Detail field assembly and attachment to building structure.
- G. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- H. Certification and test reports
- I. Welding certificates.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.

1.7 WARRANTY

- A. Manufactures standard warranty.

PART 2 PRODUCTS

2.1 GENERAL

- A. Refer to drawings for tank sizes, piping arrangement and pressure settings.

2.2 EXPANSION TANKS

- A. Drawing Designation: 04 03 CH EXT-1, 04 03 HW EXT-1.
- B. Pressurized Expansion Tank: Provide bladder type tank as manufactured by Bell & Gossett, Taco, or Amtrol. Tank shall include system connection, bladder access/replacement flanges, drain connection, lifting ring, air charging valve and floor mounting skirt for vertical installation. Tank shall be suitable for vertical and horizontal installation with lifting rings and drain connection for both installation positions. Tank shall be constructed and labeled for compliance with ASME Boiler and Pressure Vessel Code suitable for 125 psig working pressure and 375 degrees F maximum operating temperature:
 - 1. Bladder shall be replaceable heavy-duty butyl rubber securely sealed to separate air charge from system water to maintain required expansion capacity.
 - 2. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

2.3 AIR SEPARATOR

- A. Drawing Designation: 04 03 CH ASP-1, 0403 HW ASP-1.
- B. Tangential Air Separators:

1. Pipe size 1-1/2-inch and smaller. Taco Air Scoop or approved equal, with high-capacity air vent. Size as recommended by manufacturer, but not smaller than connecting main.
2. Pipe size 2-inch and larger. Equal to Bell and Gossett RL without strainer. Manufacturers: Amtrol, Bell & Gossett, Taco.
3. Separator shall be fabricated steel tank, rated for 125 psi working pressure and 375 degrees F maximum operation temperature, and shall bear ASME Inspection Certification.
4. Perforated stainless steel air collector tube constructed to direct released air into expansion tank.
5. Tangential inlet and outlet.
6. Threaded blowdown connection.

2.4 PRESSURE REDUCING VALVES

- A. Field adjustable, Watts Regulator or approved equal.

2.5 BACK FLOW PREVENTER

- A. Reduced pressure zone for connection to heating water system, chilled water system, condenser water system, and elsewhere as indicated, Watts 909 backflow preventer with strainer and valves; ASSE 1013:
 1. Sizes through 3-inch shall have full-port ball valves.
 2. Sizes 4-inch and larger shall have OS&Y rising stem gate valves.
 3. Backflow preventer 2-1/2-inch and larger shall have FDA approved epoxy coating and lining for the entire assembly including valves and strainer.
 4. Backflow preventer 2-inch and smaller shall have bronze strainer and valves; internal polymer coating for preventer body. Provide with air gap for drain outlet.

2.6 PRESSURE RELIEF VALVES

- A. ASME approved.
- B. Factory set valves protecting equipment for maximum working pressure of the equipment.
- C. Factory set system pressure limiting valves for indicated pressure. Watts Regulator or approved equal.

2.7 AIR VENTS

- A. Manual Air Vents:
 1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Screwdriver or thumbscrew.
 4. Inlet Connection: 1/2-inch.
 5. Discharge Connection: 1/8-inch.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature 225 degrees F.

B. Automatic Air Vents:

1. Taco No. 426 or approved equal.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: 1/2-inch.
6. Discharge Connection: 1/4-inch.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 degrees F.

C. High-Capacity Air Vent: Amtrol Model 720, Taco No. 418 or approved equal.

2.8 STRAINERS

A. Size and Screen Openings: Provide full line size strainers irrespective of equipment connection size. Provide free area of screen not less than 2-1/2 times inlet pipe area.

B. Single Basket Type: Mueller No. 165 with closed bottom stainless steel basket:

1. Body: ASTM A126, Class B cast iron.

C. "Y" Type:

1. For 2-inch and smaller Mueller No. 11 M with open bottom stainless-steel screen rated for 125 psig:
 - a. Body: ASTM A126, Class B, cast iron with bottom drain connection.
 - b. Threaded ends.
2. For 2-1/2-inch or larger, Mueller No. 758 with open bottom stainless-steel screen rated for 125 psig:
 - a. Body: ASTM A126, Class B, cast iron with bolted cover with drain connection.
 - b. Flanged ends.

D. Perforations: Diameter of perforations, water service 4-inch and smaller - 0.057-inch, 5-inch and larger - 0.125-inch (double diameter for condenser water service); steam service 2-inch and smaller - 0.033-inch, 2-1/2-inch and larger - 3/64-inch.

E. Magnet: Bolt Alnico channel magnets to strainer screens at suction of pumps except fuel oil systems. Provide magnets of sufficient strength and spacing to attract all ferrous particles entering strainer.

F. Drain: Pipe plug or factory-installed hose-end drain valve as indicated on drawings.

G. Galvanizing: Strainer bodies for galvanized lines shall be galvanized.

H. Manufacturers:

1. Single Basket and "Y" Type: Boylston, Keckley, McAlear, Metraflex, Mueller, Nicholson, Sarco, Spence, Tate Andale.
- I. Optional Suction Diffuser: In lieu of strainer, Contractor shall have the option to provide a cast iron angle body with straightening vanes, stainless steel combination diffuser strainer with 3/16-inch diameter openings; removable, bronze start-up strainer; adjustable support foot to relieve piping strains from pump suction. Equip units with removable magnets of sufficient strength and spacing to attract ferrous particles entering the strainer.
- J. Manufacturers: Taco, Bell and Gosset; Victaulic, Grinnell in compatible piping systems.

2.9 PRE-FABRICATED FLEXIBLE HOSE EXPANSION LOOP

A. General

1. Equivalent to Metraflex Metraloop or V-Loop.
2. Manufacturer shall be responsible for sizing the flexible hose expansion joint and provide anchor and guide locations.
3. Provide manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.

B. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder joint end connections:

1. Two-inch (and Smaller: Bronze hoses and single braid bronze sheaths with 450 psig at 70-degree F and 340 psig at 450-degree F ratings.
2. 2-1/2 to 4 inches: Stainless-steel hoses and single braid, stainless-steel sheaths with 300 psig at 70-degree F and 225 psig at 450-degree F ratings.
3. For Steam applications use double braided stainless-steel sheaths with a minimum rating of 1.5 times the steam system pressure and temperature.

C. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for 2-inch and smaller and flanged end connections for 2-1/2-inch and larger:

1. Two-inch and Smaller: Stainless-steel hoses and single braid, stainless-steel sheaths with 450 psig at 70 degrees F and 325 psig at 600-degree F ratings.
2. 2-1/2 to 6 inches: Stainless-steel hoses and single braid, stainless-steel sheaths with 200 psig at 70 degrees F and 145 psig at 600 degrees F ratings.
3. 8 to 12 inches: Stainless-steel hoses and single braid, stainless-steel sheaths with 125 psig at 70 degrees F and 90 psig at 600 degrees F ratings.
4. For Steam applications use double braided stainless-steel sheaths with a minimum rating of 1.5 times the steam system pressure and temperature.

D. Manufacturers: Flex-Hose Co., Inc., Flexicraft Industries, Flex-Pression, Ltd., Metraflex, Inc.

2.10 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.
 2. Manufacturers: Adscos, Advanced Thermal Systems, FlexHose, Flexicraft, Hyspan, Mason Industries, Metraflex.
- B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A 36/A 36M.
 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
 3. Washers: ASTM F 844, steel, plain, flat washers.
 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application:
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
 5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 EXECUTION

3.1 VALVE APPLICATIONS

- A. Install safety valves as required by ASME Boiler and Pressure Vessel Code. Install drip pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on drawings. Comply with ASME Boiler and Pressure Vessel Code; Section VIII, Division 1, for installation requirements.
- B. Install pressure-reducing valves at makeup water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install expansion tanks on the floor or in horizontal position as indicated. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system project requirements.
- B. Install and charge pressurized expansion tank in accordance with manufacturer's instructions and recommendations.
- C. The system connection and bladder access flange to the expansion tank shall be positioned so that they will be below horizontal centerline of tank if tank is installed in the horizontal position.

- D. Expansion tank 04 03 HW EXT-1 shall be part of a complete factory furnished steam to water skid package with individual equipment capacities as scheduled containing but not limited to the following:
1. Pumps (04 03 HW PMP-1 and 2) as scheduled and pump appurtenances (end suction diffuser, isolation valves, check valves, flexible connectors, cyclone abrasive separator, and pressure gauges)
 2. Air separator (04 03 HW ASP-1) as scheduled and appurtenances (automatic air vents)
 3. Heat exchanger (04 03 HW HXR-1 and 2) as scheduled and appurtenances (relief valve, vacuum breaker, isolation valves)
 4. Expansion tank (04 03 HW EXT-1) as scheduled and appurtenances (pressure gauge, vent, isolation valves)
 5. Terminal block I/O and power distribution cabinet and internal skid system control package.
 6. Pump VFD's
 7. Skid package interconnecting piping and wiring.
 8. Steam inlet/outlet connection flanges.
 9. Water inlet outlet connection flanges.
- E. Install air separator upstream of pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Air separator 04 03 HW ASP-1 shall be part of a complete factory furnished steam to water skid package noted above.
- G. Install backflow preventers where indicated on drawings and where required by code. Install air gap on reduced pressure zone backflow preventer and pipe discharge drain to floor drain. Do not install bypass piping around backflow preventers.
- H. Set pressure reducing valves as indicated.
- I. Pipe relief valve discharge to nearest floor drain or as directed. Piped discharge to drains shall terminate above drain grate so that discharge is visible.
- J. Install automatic air vents at tops of risers and high points of system except where manual air vents are indicated. Pipe overflow to nearest floor drain, service sink or as indicated.
- K. Provide high-capacity air vent on air separator.
- L. Strainers:
1. Steam: "Y" type.
 2. Water:
 - a. 2-inch and smaller - "Y" type
 - b. 2-1/2 to 16 inches, single basket type
 3. Support strainers at pumps independent of piping system.
 4. Suction diffuser type may be used in lieu of strainer for hot water heating, chilled water, systems where pipe size is 8 inches and smaller.
 - a. Support suction diffuser at pumps independent of the piping system.

3.3 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Manufacturer shall size loop and provide location of anchors and guides.
- C. Connect risers and branch connections to mains with at least five pipe fittings, including tees in main.
- D. V-Loops shall be insulated with flexible unicellular, mineral wool or fiberglass insulation. Ridged insulations should be avoided on the hose element to avoid point loading the hose.

3.4 ALIGNMENT GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B3.19 and AWS D1.1/D1.1M:
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 23 21 16

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Fluid handling equipment and associated integral supports, accessories, piping, motors and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 07 00 - HVAC Insulation
- G. Section 23 08 16 - Commissioning of HVAC Systems
- H. Section 23 20 00 - Building HVAC Services Piping
- I. Section 23 21 16 - Hydronic Piping Specialties
- J. Section 23 57 00 - Heat Exchangers
- K. Section 23 64 16 – Liquid Water Chillers
- L. Section 23 65 13 - Packaged Cooling Towers
- M. Section 25 00 00 – Chiller Plant Control System
- N. Section 25 00 10 - Hot Water Skid Control System
- O. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Equipment specified shall meet all requirements of ASHRAE Standard 90.1, Section 6.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic mechanical Materials and Methods."
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of pumps.
- C. Certified performance curves indicating operating points.
- D. Final impeller dimensions.
- E. Certification and test reports.
- F. Operation and Maintenance Data for pumps including emergency, operation and maintenance manuals.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.
- C. Furnish one additional mechanical seal for each pump in package with protective cover for storage and identified with labels describing contents.

1.7 WARRANTY

- A. Manufacturers standard warranty.

PART 2 PRODUCTS

2.1 GENERAL

- A. Impeller size for specified duty shall not exceed 85 percent of volute cutwater diameter.
- B. Maximum cataloged impeller size shall be rated to produce not less than 110 percent of specified head at specified flow.
- C. Required net positive suction head shall not exceed scheduled limit.

- D. Brake horsepower at specified conditions shall not exceed 78 percent of motor nameplate horsepower times service factor. Horsepower at any flow with selected impeller shall not exceed motor nameplate horsepower times service factor.
- E. Capacities as scheduled on drawings.
- F. Submit performance curves demonstrating compliance with above requirements.
- G. Pump construction:
 - 1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute and flanged connections.
 - 2. Impeller: ASTM B 584, stainless steel; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps without a variable frequency-motor controller, trim impeller to match specified performance.
 - 3. Pump Shaft: Stainless steel.
 - 4. Trim: Bronze or stainless steel.
 - 5. Mechanical Seal: Tungsten carbide seal and Buna-N bellows and gasket.
 - 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
 - 7. Working Pressure: 125 psig.
 - 8. Additionally, for separately coupled, base-mounted, end suction centrifugal pumps: Wear rings, bronze or stainless-steel shaft sleeves for mechanical seal pumps. Sleeves shall shroud shaft in contact with fluid and extend to outboard side of seals. For pumps with external flushing of seals, provide flushing connection to mechanical seal housings directly over seal faces:
 - a. For pumps without internal flushing of seals, provide John Crane Kynar Abrasive Separator for each mechanical seal on all separately coupled, base-mounted, end suction centrifugal pumps.
- H. Shaft Coupling for separately coupled, base-mounted, end suction centrifugal pumps: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor, if available as an option. For vertical in-line pumps, provide auxiliary split spacer coupling. Provide EPDM coupling sleeve for variable-speed applications.
- I. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- J. Mounting Frame for separately coupled, base-mounted, end suction centrifugal pumps: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- K. Motor: Single speed, secured to mounting frame, with adjustable alignment:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- L. Provide drain rim base with deflector plates beneath outboard surfaces for pumps handling fluids 60 degrees F or lower to collect condensation from cold surfaces. Equip with drain connection.

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END SUCTION CENTRIFUGAL PUMPS

- A. Drawing Designation: 04 03 CH PMP-1, 2, and 3. 04 03 CW PMP-1, 2, and 3.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Equivalent to Bell and Gossett e-1510.
- C. Motor shall be secured to mounting frame with adjustable alignment.
- D. Manufacturers: Allis-Chalmers, Armstrong, Aurora, Bell and Gossett, Buffalo, Goulds, Ingersoll Rand, Patterson, Taco, Weinman.

2.3 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- A. Drawing Designation: 04 03 HW PMP-1 and 2.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Equivalent to Bell and Gossett e-80SC.
- C. Pump shall be pull out design for pump service without disconnecting piping connected to the pump.
- D. Pump shall have support connection for support of pump independent of piping.
- E. Motor shall be rigidly mounted to pump casing with lifting eyebolt and supporting lugs in motor enclosure.
- F. Manufacturers: Allis-Chalmers, Armstrong, Aurora, Bell & Gossett, Buffalo, Goulds, Ingersoll Rand, Taco, Weinman.

2.4 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Drawing Designation: 04 10 HW PMP-1, 2, and 3.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts horizontal. Equivalent to Bell and Gossett e-90.
- C. Stainless steel or brass sleeved steel shaft.
- D. Oil lubricated sleeve bearings.
- E. Motor rigidly mounted to pump casing.
- F. Manufacturers: Armstrong, Bell & Gossett, Patterson, Taco, Thrush.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Equipment Mounting:
 - 1. Separately coupled, base-mounted, end suction centrifugal pumps:
 - a. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete." Comply with requirements for vibration isolation control devices specified in Section 23 05 48 "Mechanical Sound and Vibration Controls."
 - b. Install vertical in-line pumps with continuous threaded hanger rods and of size required to support weight of in-line pumps.
- E. Pipe condensation drain pans to nearest floor drain using 1/2-inch galvanized piping. Provide protective ramps in aisles.
- F. Pipe separators, where required, with 1/2-inch copper tubing with inlet connected to pump discharge, clean outlet to seal and dirty outlet to pump suction.
- G. Provide support for vertical in-line pumps from base of pump to floor or wall bracket so that pump is not supported from piping.

3.3 ALIGNMENT

- A. Perform alignment service.
- B. After final connection of piping, grouting of base, and adjustment of vibration isolation, comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes equal to sizes indicated on drawings.
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

- A. Perform startup service:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.6 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- 1. Pumps shall be part of a complete factory furnished steam to water skid package with individual equipment capacities as scheduled containing but not limited to the following:
 - a. Pumps (04 03 HW PMP-1 and 2) as scheduled and pump appurtenances (end suction diffuser, isolation valves, check valves, flexible connectors, cyclone abrasive separator, and pressure gauges)
 - b. Air separator (04 03 HW ASP-1) as scheduled and appurtenances (automatic air vents)
 - c. Heat exchanger (04 03 HW HXR-1 and 2) as scheduled and appurtenances (relief valve, vacuum breaker, isolation valves)
 - d. Expansion tank (04 03 HW EXT-1) as scheduled and appurtenances (pressure gauge,

- vent, isolation valves)
- e. Terminal block I/O and power distribution cabinet and internal skid system control package.
- f. Pump VFD's
- g. Skid package interconnecting piping and wiring.
- h. Steam inlet/outlet connection flanges.
- i. Water inlet outlet connection flanges.

3.7 DEMONSTRATION

- A. Train Government's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 23 21 23

SECTION 23 22 16 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. Piping specialties for steam and condensate piping:

1. Strainer.
2. Flash Tanks.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Flexible connectors.
8. Meter.

1.2 RELATED DIVISIONS AND SECTIONS:

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 93 - Testing, Adjusting, and Balancing
- D. Section 23 07 00 - HVAC Insulation
- E. Section 23 08 16 - Commissioning of HVAC System
- F. Section 23 20 00 - Building HVAC Services Piping
- G. Section 23 57 00 – Heat Exchangers
- H. Section 25 00 00 – Chiller Plant Control System
- I. Section 25 00 10 – Hot Water Skid Control System

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Strainers.
2. Flash tanks.
3. Safety Valves.
4. Pressure reducing valves.
5. Steam traps.
6. Air vent and vacuum breaker.
7. Flexible Connector.

8. Meter.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Acceptable Manufacturers, Spirax Sarco, Armstrong or approved equal.
- B. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
 1. MP Steam Piping: 50 psig.
 2. LP Steam Piping: 15 psig.
 3. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.
 4. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
 5. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

2.2 STRAINERS

- A. Y-Pattern Strainers, Cast Iron:
 1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 3. Strainer Screen: Stainless steel, 40-mesh strainer or perforated stainless-steel basket.
 4. Tapped blowoff plug.
 5. Rating: 250-psig working steam pressure.
- B. Basket Strainers:
 1. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 and larger.
 3. Strainer Screen: Stainless steel, 20-mesh strainer and perforated stainless steel basket with 50 percent free area.
 4. Rating: 250-psig working steam pressure.

2.3 FLASH TANKS

- A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code for 150-psig rating, and bearing ASME label. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs,

2.4 STOP-CHECK VALVES

- A. Stop-Check Valves:
 - 1. Body and Bonnet: Malleable iron.
 - 2. End Connections: Flanged.
 - 3. Disc: Cylindrical with removable liner and machined seat.
 - 4. Stem: Brass alloy.
 - 5. Operator: Outside screw and yoke with cast-iron handwheel.
 - 6. Packing: PTFE-impregnated packing with two-piece packing gland assembly.
 - 7. Pressure Class: 250.

2.5 STEAM SAFETY VALVES

- A. Bronze or Brass Steam Safety Valves: ASME labeled:
 - 1. Disc Material: Forged copper alloy.
 - 2. End Connections: Threaded inlet and outlet.
 - 3. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - 4. Pressure Class: 250.
 - 5. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet, with threads complying with ASME B1.20.1.
 - 6. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 PRESSURE-REDUCING VALVES

- A. Capacities and Characteristics:
 - 1. As scheduled on drawings.
- B. ASME labeled.
- C. Size, Capacity, and Pressure Rating: Factory set for inlet and outlet pressures.
- D. Description: Pilot-actuated diaphragm type, with adjustable pressure range and positive shutoff.
- E. Body: Cast iron.
- F. End Connections: Threaded connections for valves 2-inch and smaller and flanged connections for valves 2-1/2-inch and larger.

- G. Trim: Hardened stainless steel.
- H. Head and Seat: Replaceable, main head stem guide fitted with flushing and pressure-arresting device cover over pilot diaphragm.
- I. Gaskets: Non-asbestos materials.

2.7 STEAM TRAPS

A. Thermostatic Steam Traps, Bronze:

- 1. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
- 2. Trap Type: Balanced pressure.
- 3. Bellows: Stainless steel or monel.
- 4. Head and Seat: Replaceable, hardened stainless steel.
- 5. Pressure Class: 125.

B. Float and Thermostatic Steam Traps, Cast Iron:

- 1. Body and Bolted Cap: ASTM A126 cast iron.
- 2. End Connections: Threaded.
- 3. Float Mechanism: Replaceable, stainless steel.
- 4. Seat: Hardened stainless steel.
- 5. Trap Type: Balanced pressure.
- 6. Thermostatic Bellows: Stainless steel or monel.
- 7. Thermostatic air vent capable of withstanding 45 degrees F of superheat and resisting water hammer without sustaining damage.
- 8. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
- 9. Maximum Operating Pressure: 125 psig.

C. Inverted Bucket Steam Traps, Cast Iron:

- 1. Body and Cap: Cast iron.
- 2. End Connections: Threaded.
- 3. Head and Seat: Stainless steel.
- 4. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
- 5. Bucket: Brass or stainless steel.
- 6. Strainer: Integral stainless steel inlet strainer within the trap body.
- 7. Air Vent: Stainless steel thermostatic vent.
- 8. Pressure Rating: 250 psig.

2.8 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

- 1. Body: Cast iron, bronze, or stainless steel.
- 2. End Connections: Threaded.
- 3. Float, Valve, and Seat: Stainless steel.
- 4. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.

5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 degrees F.

B. Vacuum Breakers:

1. Body: Cast iron, bronze, or stainless steel.
2. End Connections: Threaded.
3. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
4. O-Ring Seal: Ethylene propylene rubber.
5. Pressure Rating: 125 psig.
6. Maximum Temperature Rating: 350 degrees F.

2.9 FLEXIBLE CONNECTORS

A. Stainless Steel Bellows, Flexible Connectors:

1. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 degrees F.

2.10 STEAM METERS

A. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation
4. Microprocessor Enclosure: NEMA 250, Type 4.
5. Sensor:
 - a. Vortex type with stainless steel wetted parts and [wafer] [flange] connections; and with a piezoelectric sensor removable and serviceable without shutting down the process. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

2.11 CONDENSATE METERS

- A. Body: Cast iron, bronze, or brass.
- B. Turbine: Copper, brass, or stainless steel.
- C. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.
- D. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms

for high and low flow rate, pressure, and temperature.

1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
2. Independent timers to store four peak flow rates and total flow.
3. Interface compatible with central workstation.
4. Microprocessor Enclosure: NEMA 250, Type 4.
5. Pressure Rating: Atmospheric.
6. Maximum Temperature Rating: 250 deg F.

PART 3 EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.
- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.2 INSTALLATION OF PIPING

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, 3/4- inch full-port ball valve, and short NPS 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install valves according to Section 23 20 00 "Building HVAC Services Piping."
- D. Install unions in piping, 2-inch and smaller, adjacent to valves, at final connections of equipment and elsewhere as indicated.
- E. Install flanges in piping, 2-1/2 inch and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install 3/4-inch nipple and full-port ball valve in blowdown connection of strainers 2-inch and larger. Match size of strainer blowoff connection for strainers smaller than 2-inch.

3.3 INSTALLATION OF FLASH TANKS

- A. Pitch condensate piping down toward flash tank.

- B. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
- C. Install thermostatic air vent at tank top.
- D. Install safety valve at tank top.
- E. Install full-port ball valve, and swing check valve on condensate outlet.
- F. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for 3 times the calculated heat load.

3.4 INSTALLATION OF STEAM TRAPS

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.5 INSTALLATION OF PRESSURE-REDUCING VALVES

- A. Install pressure-reducing valves in accessible location for maintenance and inspection.
- B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.
- C. Install gate valves on both sides of pressure-reducing valves.
- D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections, respectively.
- E. Install pressure gages on low-pressure side of pressure-reducing valves and after the bypass connection.
- F. Install strainers upstream for pressure-reducing valve.
- G. Install safety valve downstream from pressure-reducing valve station.

3.6 INSTALLATION OF STEAM OR CONDENSATE METERS

- A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.
- B. Provide data acquisition wiring.

3.7 INSTALLATION OF SAFETY VALVES

- A. Install safety valves according to ASME B31.1, "Power Piping," and ASME B31.9, "Building Services Piping."

- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than 2-1/2-inch.

3.8 TERMINAL EQUIPMENT CONNECTIONS

- A. Install traps and control valves in accessible locations close to connected equipment.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

END OF SECTION 23 22 16

SECTION 23 25 00 - WATER TREATMENT SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Water treatment equipment for chilled water, heating water, and condenser water systems and associated integral supports, accessories, piping, motors and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- D. Section 23 08 16 - Commissioning of HVAC System
- E. Section 23 20 00 - Building HVAC Services Piping
- F. Section 23 21 16 – Hydronic Piping Specialties
- G. Section 23 21 23 - Hydronic Pumps
- H. Section 23 25 33 – HVAC Water Filtration Equipment
- I. Section 23 57 00 – Heat Exchangers
- J. Section 23 64 16 - Liquid Water Chillers
- K. Section 23 65 13 - Packaged Cooling Towers
- L. Section 23 82 39 - Unit Heaters

1.3 QUALITY ASSURANCE

- A. HVAC: Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of components:
 - 1. Water meters.
 - 2. Inhibitor injection timers.
 - 3. pH controllers.
 - 4. TSS controllers.
 - 5. Biocide feeder timers.
 - 6. Chemical solution tanks.
 - 7. Injection pumps.
 - 8. Chemical test equipment.
 - 9. Chemical material safety data sheets.
- C. Shop Drawings: Pretreatment and chemical, and biocide treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems:
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal and control wiring.
- D. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- E. Water Analysis: Illustrate water quality available at Project site.
- F. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.

1.7 DEFINITIONS

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended, solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operation at less than 50V or for remote-control signaling power-limited circuits.

PART 2 PRODUCTS

2.1 GENERAL

- A. Contractor shall coordinate with existing water treatment supplier/contractor to determine scope of work required.
- B. Provide a complete system of water treatment including service, equipment and chemicals supplied by a single water treatment company.
- C. The water treatment system supplier shall be a recognized specialist, active in the field of industrial water treatment for at least ten years, and shall have water analysis laboratories, development facilities and service department and full-time service personnel located within 60 miles of the project.
- D. The water treatment system supplier shall provide service for a period of one year from start-up of the system including the following, all performed by qualified full-time personnel:
 - 1. Initial water analysis.
 - 2. Initial flushing of cooling tower system with detergent-disinfectant solution.
 - 3. System start-up assistance.
 - 4. Instruction of operating personnel.
 - 5. Periodic field service and consultation.
 - 6. Chemicals as required for one-year operation from start-up shall be included.
- E. Chemicals used shall meet all Federal, District, and local regulations.
- F. Provide test kit for testing each water treatment system.
- G. See Section 23 05 00, "Basic Mechanical Methods and Materials," for cleaning of systems.
- H. Water Treatment Supplier: ARC Water Treatment Co. of Maryland, Inc., Nelcor, Water Chemical Services, Inc.

2.2 PERFORMANCE REQUIREMENTS

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or to the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics and requirements and guidelines of Authorities Having Jurisdiction.
- C. Open hydronic systems, including condenser water:

- D. Provide water treatment program equal to the following system by ARC Water Treatment Co. of Maryland, Inc.:
1. LMI Model DC-4500 controller for automatic bleed-off, metered make-up chemical feed control module, and biocide programmer module. Control panel shall be single NEMA 12 enclosure fully prewired, primed and painted. Lights indicating power, flow, feed, and bleed-off status shall be included. Conductivity indicating meters and alarm shall be provided.
 2. One conductivity probe in a probe fitting with shutoff valves.
 3. One bleed-off solenoid and throttling valve sized for system bleedoff.
 4. One LMI Model P021-352TI chemical feed pump, and one LMI Model P051-392TT biocide feed pump, positive displacement type, with check valves, motor, and discharge relief valve.
 5. Sample stream flow switch to start and stop system.
 6. One stop and injection assembly for each pump with PVC diffuser tube and check valve for injecting chemicals into recirculating line.
 7. Water meter and contactor.
 8. Provide chemicals and containers for control of scale, corrosion, algae, slime, and microbiological growth.
 9. Provision for manual operation of each system.
 10. Fifty-gallon chemical solution tank with pump.
 11. Whenever initial water analysis indicates that alkalinity exceeds 125 PPM or hardness exceeds 300 PPM, provide an acid feed system including 30-gallon container, LMI Model P151-3985 pump, pH sensor, and feed controller.
 12. Legionella Test:
 - a. Perform bi-monthly (every two months) tests of the cooling tower water for Legionella Pneumophila.
 - b. Tests shall be conducted in a certified laboratory not by a technician in the field.
 - c. Submit reports to Owner stating bacteria count per milliliter and the results from the previous tests.
- E. Passivation for Galvanized Steel: For first 60 days of operation.
1. pH: Maintain a value within 7 to 8.
 2. Calcium Carbonate Hardness: Maintain a value within 100 to 300 ppm.
 3. Calcium Carbonate Alkalinity: Maintain a value within 100 to 300 ppm.

2.3 AUTOMATIC CHEMICAL-FEED EQUIPMENT (OPEN SYSTEM)

A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Inhibitor Injection Timers:

1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 25 00 00 "Chiller Plant Control System" and 25 00 10 "Hot Water Control System."
2. Programmable timers with infinite adjustment over full range, and mounted in cabinet with hand-off-auto switches and status lights.
3. Test switch.
4. Hand-off-auto switch for chemical pump.
5. Illuminated legend to indicate feed when pump is activated.
6. Programmable lockout timer with indicator light. Lockout timer to deactivate the pump and activate alarm circuits.
7. Digital display totalizer to measure amount of makeup and bleed-off water from two water meter inputs.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. pH Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 14 units. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 25 00 00 "Chiller Plant Control System" and 25 00 10 "Hot Water Control System"
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal pH indication.
5. High or low-pH-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for acid pump.
7. Internal adjustable hysteresis or deadband.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. TSS Controller:

1. Microprocessor-based controller, 1 percent accuracy in a range from zero to 5000 micromhos. Incorporate solid-state integrated circuits and digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 25 00 00 "Chiller Plant Control System" and 25 00 10 "Hot Water Control System"
2. Digital display and touch pad for input.
3. Sensor probe adaptable to sample stream manifold.
4. High, low, and normal conductance indication.
5. High- or low-conductance-alarm-light trip points, field adjustable; with silence switch.
6. Hand-off-auto switch for solenoid bleed-off valve.
7. Bleed-off valve activated indication.
8. Internal adjustable hysteresis or deadband.
9. Bleed Valves:
 - a. Cooling Systems: Forged-brass body, globe pattern, general-purpose solenoid with continuous-duty coil, or motorized valve.

10. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Biocide Feeder Timer:
1. Microprocessor-based controller with digital display in NEMA 250, Type 12 enclosure with gasketed and lockable door. Interface for start/stop and status indication at central workstation as described in Section 25 00 00 "Chiller Plant Control System" and 25 00 10 "Hot Water Control System"
 2. 24-hour timer with 14-day skip feature to permit activation any hour of day.
 3. Precision, solid-state, bleed-off lockout timer and clock-controlled biocide pump timer. Prebleed and bleed lockout timers.
 4. Solid-state alternator to enable use of two formulations.
 5. 24-hour display of time of day.
 6. 14-day display of day of week.
 7. Battery backup so clock is not disturbed by power outages.
 8. Hand-off-auto switches for biocide pumps.
 9. Biocide A and Biocide B pump running indication.
- F. Chemical Solution Tanks:
1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
 2. Molded cover with recess for mounting pump.
 3. Capacity: 50 gal.
 4. Chemical Solution Injection Pumps:
 5. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
 6. Adjustable flow rate.
 7. Metal and thermoplastic construction.
 8. Built-in relief valve.
 9. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 23 05 00 "Basic Mechanical Materials and Methods."
 10. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.
- H. Injection Assembly:
1. Quill: Minimum 1/2-inch with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
 2. Ball Valve: Two-piece stainless steel, as described in "Stainless-Steel Pipes and Fittings" Article; selected to fit quill.
 3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
 4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 degrees F.
- 2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT (CLOSED SYSTEMS)
- A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac, and that will close at adjustable increments of total flow.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 15 gal.

C. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 23 05 00 "Basic Mechanical Materials and Methods."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
7. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

D. Injection Assembly:

1. Quill: Minimum 1/2-inch with insertion length sufficient to discharge into at least 25 percent of pipe diameter.
2. Ball Valve: Two-piece stainless steel, as described in "Stainless-Steel Pipes and Fittings" Article; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 degrees F.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

- A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
- B. Stainless-Steel Fittings: Comply with ASTM A 815/A 815M, Type 316, Grade WP-S.
- C. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351/A 351M, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig Steam Working Pressure and 600-psig Cold Working Pressure rating.

2.6 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TSS, inhibitor, chloride, alkalinity, and hardness; and oxidizing biocide test for open cooling systems.
- B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
 - 1. Two-station rack for closed-loop systems.
 - 2. Four-station rack for open-loop systems.

2.7 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain water quality specified in "Performance Requirements" Article.

PART 3 PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.
- B. Provide a written report of the water analysis and the chemicals recommended for use, their concentrations and the pH to be maintained.

3.2 INSTALLATION

- A. Install chemical application equipment on concrete bases level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
 - 1. Install water-testing equipment on wall near water-chemical-application equipment.
 - 2. Install interconnecting control wiring for chemical treatment controls and sensors.
 - 3. Mount sensors and injectors in piping circuits.
 - 4. Install water meter in makeup-water supply.
 - 5. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
 - 6. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
 - 7. Install a swing check on inlet after the isolation valve.
- B. Install automatic chemical-feed equipment for chilled water, heating hot water, and condenser water and include the following:
 - 1. Coordinate with installation of makeup-water softener specified under another Section.
 - 2. Install water meter in makeup-water supply.

3. Install inhibitor injection pumps and solution tanks with injection timer sensing contacts in water meter:
 - a. Pumps shall operate for timed interval on contact closure at water meter in makeup-water supply connection.
4. Install test equipment and provide test-kit to Government. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
5. Install TSS controller with sensor and bleed valves:
 - a. Bleed valves shall cycle to maintain maximum TSS concentration.
6. Install pH sensor and controller with injection pumps and solution tanks:
 - a. Injector pumps shall operate to maintain required pH.
7. Install biocide feeder alternating timer with two sets of injection pumps and solution tanks:
 - a. Injection pumps shall operate to feed biocide on an alternating basis.

3.3 CONNECTIONS

- A. Comply with requirements in See Section 22 40 00 "Plumbing Fixtures and Equipment" for backflow preventers required in makeup-water connections to potable-water systems.
- B. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC system's startup procedures.
 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. At eight-week intervals following Substantial Completion, perform separate water analyses on open hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Government of changes necessary to adhere to "Performance Requirements" Article.
- E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
 2. Acidity and Alkalinity: ASTM D 1067.
 3. Iron: ASTM D 1068.
 4. Water Hardness: ASTM D 1126.
- F. Provide certification that chemicals comply with health codes and will have no detrimental effect on the system in which it is to be used.
- G. Provide water test equipment.
- H. Provide necessary piping and wiring connections, including valves and accessories, for installation of equipment to provide the required treatment.
- I. Provide a written report that the cooling tower system has been circulated a minimum of 24 hours with a solution containing an adequate high-alkali detergent and a compatible biocide or disinfectant and that tests have been performed which indicate that sufficient amounts of the active detergent-disinfectant were present at the end of the minimum 24-hour period. After flushing operation is complete, drain and refill system with fresh water and add an initial charge of an EPA biocide. After flushing and refill are complete, do not operate cooling tower system for any purpose unless the chemical treatment system is operational. Replace all chemicals used.
- 3.5 MAINTENANCE SERVICE
- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for chilled water piping, heating water piping, condenser water piping, and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.

2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 23 25 00

SECTION 23 25 33 - HVAC WATER FILTRATION EQUIPMENT

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. HVAC water filtration equipment and associated integral supports, accessories, piping, motors and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- D. Section 23 05 93 - Testing, Adjusting, and Balancing
- E. Section 23 07 00 - HVAC Insulation
- F. Section 23 08 16 - Commissioning of HVAC System
- G. Section 23 20 00 - Building HVAC Services Piping
- H. Section 23 21 16 – Hydronic Piping Specialties
- I. Section 23 21 23 – Hydronic Pumps
- J. Section 23 57 00 - Heat Exchangers
- K. Section 23 64 16 - Liquid Water Chillers
- L. Section 23 65 13 - Packaged Cooling Towers
- M. Section 23 73 43 – Outdoor Custom Air Handling Units
- N. Section 25 00 00 – Chiller Plant Control System
- O. Section 25 00 10 – Hot Water Skid Control System
- P. Section 25 00 20 – Air Handlers Control System
- Q. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of components:
 - 1. HVAC Makeup-Water Softeners.
 - 2. RO Equipment for HVAC Makeup Water.
 - 3. Cartridge/Type Filters.
 - 4. Cartridge Filter housing.
 - 5. Solids Separators.
 - 6. Water-Softener Chemicals.
- C. Wiring Diagrams.
- D. Water Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- E. Water Analysis: Illustrate water quality available at Project site.
- F. Operation and Maintenance Data: For sensors, injection pumps, water softeners, /RO equipment, water filtration units, and controllers to include in emergency, operation, and maintenance manuals.
- G. Test reports for water quality.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.

1.7 WARRANTY

- A. Manufacturers standard warranty.

1.8 DEFINITIONS

- A. RO: Reverse osmosis.
- B. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

PART 2 PRODUCTS

2.1 HVAC MAKEUP-WATER SOFTENER

- A. Description: Twin mineral tanks and one brine tank, factory mounted on skid.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
- D. Mineral Tanks:
 - 1. Fabricate and label filter tanks to comply with ASME Boiler and Pressure Vessel Code: Section X, if indicated.
 - 2. Pressure Rating: 100 psig minimum.
 - 3. Wetted Components: Suitable for water temperatures from 40 to at least 100 degrees F.
 - 4. Freeboard: 50 percent, minimum, for backwash expansion above the normal resin bed level.
 - 5. Support Legs or Skirt: Constructed of structural steel, welded or bonded to tank before testing and labeling.
 - 6. Upper Distribution System: Single-point type, fabricated from 316 stainless-steel pipe and fittings.
 - 7. Lower Distribution System: Hub and radial-arm or header-lateral type; fabricated from PVC pipe and fittings with individual, fine-slotted, nonclogging polyethylene strainers; arranged for even-flow distribution through resin bed.
- E. Controls: Automatic; factory mounted on mineral tanks and factory wired:
 - 1. Adjustable duration of regeneration steps.
 - 2. Push-button start and complete manual operation override.
 - 3. Pointer on pilot-control valve shall indicate cycle of operation.
 - 4. Means of manual operation of pilot-control valve if power fails.
 - 5. Main Operating Valves: Industrial, automatic, multiport, diaphragm type with the following features:
 - a. Slow opening and closing, nonslam operation.
 - b. Diaphragm guiding on full perimeter from fully open to fully closed.
 - c. Isolated dissimilar metals within valve.
 - d. Self-adjusting, internal, automatic brine injector that draws brine and rinses at constant rate independent of pressure.
 - e. Float-operated brine valve to automatically measure the correct amount of brine to the

- softener and refill with fresh water.
 - f. Sampling cocks for soft water.
- 6. Flow Control: Automatic control of backwash and flush rates over variations in operating pressures that do not require field adjustments. Equip mineral tanks with automatic-reset-head water meter that electrically activates cycle controller to initiate regeneration at preset total in gallons and that automatically resets after regeneration to preset total in gallons for next service run. Include alternator to regenerate one mineral tank with the other in service.
- F. Brine Tank: Combination measuring and wet-salt storing system:
 - 1. Tank and Cover Material: Epoxy painted steel.
 - 2. Brine Valve: Float operated and plastic fitted for automatic control of brine withdrawn and freshwater refill.
 - 3. Size: Large enough for at least four regenerations at full salting.
 - 4. Factory-Installed Accessories:
 - 5. Piping, valves, tubing, and drains.
 - 6. Sampling cocks.
 - 7. Main-operating-valve position indicators.
 - 8. Water meters.
- G. Water Test Kit: Include in wall-mounting enclosure for water softener.
- H. Manufacturers: CSI Water Treatment System, Culligan, CUNO, Diamond Water, Ecodyne, Hungerford & Terry, Kinetico, Marlo, Parker Boiler, Pentair, Rain Soft, Water Ring.

2.2 RO EQUIPMENT FOR HVAC MAKEUP WATER

- A. Additional RO requirements for the humidification system are specified in Specification 23 73 43, "Outdoor Custom Air Handling Units."
- B. Description: Factory fabricated and tested with RO membrane elements in housings, high-pressure pumps and motors, controls, valves, and prefilter; mounted on skid.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Fabricate supports and attachments to tanks with reinforcement strong enough to resist tank movement during seismic event when tank supports are anchored to building structure as recommended in writing by manufacturer.
- E. Skid Assembly: Welded-steel frame coated with epoxy protective finish.
- F. RO Membrane and Housing:
 - 1. Element: Thin-film composite with U-cup brine seal with minimum 98 percent salt rejection based on 2000-ppm water supplied at 225 psig and 77 degrees F.
 - 2. Housing: ASTM A 666, Type 304 stainless steel with PVC end caps held in place with stainless-steel straps.
- G. High-Pressure Pumps and Motors:

1. Pump:
 - a. Vertical, multistage centrifugal operating at 3500 rpm with ASTM A 666, Type 304 stainless-steel casing, shaft, impellers, and inlet and discharge casing.
 - b. Bearings shall be tungsten carbide and ceramic.
 - c. Cast-iron frame and flanged suction and discharge connections.
 2. Motor: NEMA-standard, C-faced, totally enclosed, fan-cooled motor supported on the pump-bearing frame.
- H. Controls:
1. Microprocessor-based controller with digital display.
 2. Interlock for remote start/stop control.
 3. Membrane flush sequence when pumps shut down.
 4. Run time indicator.
 5. Low-pressure safety cutoff.
 6. Panel-mounted gages as follows:
 - a. Product and concentrate.
 - b. Inlet, cartridge filter outlet, RO feed, RO concentrate, and RO product pressures.
 - c. Product conductivity monitor.
- I. Valves:
1. Stainless-steel pump, concentrate, and recycle throttling valves rated for minimum 300 psig.
 2. Automatic inlet shutoff valve, diaphragm type; solenoid actuated, normally closed, and constructed of glass-reinforced noryl thermoplastic.
 3. PVC valves with EPDM seats and seals for isolation at inlet, and check and sample valves at product and concentrate. Sample valves at cartridge filter outlet, concentrate, and product outlet.
- J. Prefilter:
1. Housing: Polypropylene with built-in relief or vent valve.
 2. Element: Spun-wound polypropylene.
- K. Inlet Water Tempering Valve: Thermostatic water-tempering valve to maintain 77 degrees F inlet water temperature to RO unit.
- L. Activated Carbon Filter:
1. Media Tank: Fiberglass-reinforced polyester rated for minimum 150 psig with internal backwash distributor and filtered water collector.
 2. Media: 12-by-40-mesh, bituminous coal-based activated carbon.
 3. Backwash Valve: Piston-operated control valve with drain-line, flow-control orifice.
 4. Backwash Control: Seven-day time clock.
- M. Atmospheric Storage Tank:
1. Tank: Polyethylene single piece with closed top and flat bottom with manway in top, 0.2-micron filter vent, inlet, discharge, and drain piping connections, and bulkhead fittings for

- level controls.
- 2. Control: Level switches start and stop RO unit. Low-level limit shall stop repressurization pumps, and signal an alarm.

N. Repressurization Pumps:

- 1. Pumps: Two close-coupled, single-stage centrifugal pumps, with mechanical seals. Wetted components ASTM A 666, Type 316 stainless steel.
- 2. Controls: NEMA 250, Type 4X pump control panel constructed of fiberglass to control pumps, one operating and one standby, with automatic alternator and fail-over control.
- 3. Motor: Open, dripproof motor supported on the pump-bearing frame.

O. Water Test Kit: Include in wall-mounting cabinet for RO unit.

P. Manufacturers: CSI Water Treatment System, Culligan, CUNO, Diamond Water, Ecodyne, Hungerford & Terry, Kinetico, Marlo, Parker Boiler, Pentair, Rain Soft, Water Ring.

2.3 CARTRIDGE -TYPE FILTERS

A. Drawing Designation: 04 03 CH FLT-1 and 04 03 HW FLT-1.

B. Description: Floor-mounting housing with filter cartridges for removing particles from water equal to Shelco MB series cartridge filters and Shelco FOS Series housing:

- 1. Housing: Corrosion resistant; designed to separate inlet from outlet and to direct inlet through cartridge-type water filter; with base, feet, or skirt:
 - a. Pipe Connections 2-inch and Smaller: Threaded according to ASME B1.20.1.
 - b. Steel Housing Pipe Connections 2-1/2-inch and Larger: Steel, Class 150 flanges according to ASME B16.5.

- 2. Cartridge: Replaceable; of shape to fit housing.

C. Housing:

- 1. Material: Stainless steel.
- 2. Pressure Rating: 150 psig.
- 3. Seal Material: Nitrile rubber.
- 4. Connection: Inlet, Outlet, Vent and Drain.
- 5. Bag Support Basket Material: Stainless steel.

D. Media Material: Cellulose acetate or Polypropylene tubes, tinned-steel center cores, with migration control:

- 1. 2-1/2 by 10 inch.
- 2. Provide Government with two complete sets of filter elements.

E. Operating Temperature Rating: 250 degrees F.

F. Manufacturers: Commercial Filter Corp., Cyeron, Eden Equipment, Facet Enterprises, Filter Specialists, Filtration Systems, Hayward Flow Control, Parker Hannifin, Pall Corp., Pentair, PEP

Filters, Rain Soft, Rosedale, Shelco, US Filter.

2.4 SOLIDS SEPARATORS

- A. Drawings Designation: 04 10 CW FLT-1, 2 and 3.
- B. Description: Simplex separator housing with baffles and chambers for removing particles from water by centrifugal action equal to Lakos TCI series.
- C. Primary Purpose: The system will remove unwanted solids from a cooling tower sump or remote basin using a centrifugal-action vortex separator. The liquid-solids separation system will help prevent particle fouling of the cooling system's components, reduce maintenance and servicing routines, maintain optimum energy efficiency of the heat exchange process, limit blow down & chemical use practices and control harmful bacteria growth in the basin/sump. Fluid viscosity must be 100 SSU or less.
- D. For Cooling Tower Basin Use: A completely assembled package shall be supplied for the isolated recirculation and particle separation/filtration of the fluid in the cooling tower basin/remote sump in order to prevent troublesome accumulation of solids in the tower basin/sump. Flow through the separator package shall be continuous, without interruption for the periodic evacuation of separated solids. Placement of the separator package's inlet and outlet within the basin/sump shall be strategically determined and supplemented where necessary with specific flow enhancement/agitation devices known as Hydroboosters.
- E. Testing Requirements: Each unit must be tested by the manufacturer prior to shipment to ensure it conforms to stated operating specifications.
 - 1. Independent Testing Laboratory – Performance of said products must be verified by published results from an independent and identified testing laboratory. Standard test protocol of upstream injection, downstream capture, and separator purge recovery is allowed with 50-200 mesh particles to enable effective, repeatable results. Single pass test performance must not be less than 95% removal. Model tested must be of same flow-design as specified unit.
- F. Warranty: The solid separator filtration package shall have a warranty of:
 - 1. 5 years for the solid separator vessel to be free from manufacturer's defects.
 - 2. All other components: 12 months from date of installation; if installed 6 months or more after ship date, warranty shall be a maximum of 18 months from ship date.
- G. Performance
 - 1. Flow Capacity: Unit shall have a minimum flow capacity of 200 US GPM
 - 2. Pressure Loss: Shall be between 3-12 psi remaining constant, varying only when the flow rate changes.
- H. Solids Removal Effectiveness
 - 1. In Recirculating Systems: 98% performance is predictable to as fine as 40 microns (given solids with a specific gravity of 2.6), with correspondingly higher aggregate performance percentages (up to 90%) of solids as fine as 5 microns.

2. Maximum working pressure: 150 psi.
 3. Maximum operating temperature: 100° F.
- I. HydroBoosters: Each HydroBooster shall be capable of increasing its input flow, at 20 psi or more, to six times greater output flow without abrasive wear to the HydroBooster, thereby providing the proper directed turbulence to prevent troublesome solids accumulation and induce separable solids to the separator package's pump suction. Required submergence shall be as little as 2-3 inches.
- J. Base Skid Construction
1. The separator package: Shall provide for initial pre-straining prior to pump suction (except for side-stream applications), followed by direct pumping through a specific centrifugal-action solids-from-liquid separator. Separated solids shall be continuously bled from the separator's collection chamber into the package's integral solids recovery vessel and solids collection bag. Excess liquid shall pass through the bag and return to system flow via piping connected to the package's pump suction line. Alternatively, the separated solids may be purged periodically to desired disposal with an automatic purge valve.
 2. Strainer: Cast-iron housing; manual-cleaning; 9/32-inch minimum mesh rating; stainless steel basket.
 3. Pump: End-suction, single stage; TEFC motor; cast iron housing; iron impeller; bronze shaft sleeve; silicon carbide mechanical shaft seal; flooded suction required.
 4. Separator: Centrifugal-action design, incorporating a true tangential inlet and mutually tangential Swirlex internal accelerating slots, employed to promote the proper velocity necessary for the removal of the separable solids. The internal accelerating slots shall be spiral-cut for optimum flow transfer, laminar action and particle influence into the separation barrel. The separator's internal vortex shall allow this process to occur without wear to the accelerating slots. Separated particle matter shall spiral downward along the perimeter of the inner separation barrel, in a manner which does not promote wear of the separation barrel, and into the solids collection chamber, located below the vortex deflector plate. The separator shall be of unishell construction with SA-36, SA-53B or equivalent quality carbon steel, minimum thickness of .25 inches.
 5. Automatic Purge Valve: In place of the solids recovery vessel, an electrically-actuated valve shall be programmed at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. Valve body shall be bronze. Valve ball shall be stainless steel with sealant seat.
 6. Inlet and Outlet: Inlet shall be a 4" ANSI flanged connection and the outlet shall be a 4" grooved coupling connection.
 7. Purge Outlet: Shall be threaded, size 3/4" connection
 8. Piping: Schedule 40 galvanized carbon steel; reinforced rubber hose to solids recovery vessel.
 9. Electrical Control: IEC starter with overload module; HOA selector switch; NEMA-4x enclosure; re-set/disconnect/trip switch; other characteristics per equipment schedules.
 10. Valves: Ball valves on purge line for isolation of solids-handling/purging equipment. Inlet and outlet valves shall be provided by the installing contractor.
 11. Skid Plate: Stainless steel, 3/16-inch minimum thickness
 12. Paint Coating: Shall be oil-based enamel.
- K. UV Treatment Module
1. Centrifugal separator package to be provided with factory installed integral Glasco UV low pressure high output UV light disinfection equipment. The equipment shall be designed for

50 GPM of side with 30 mJ/cm² output end-of-life dose at 90% UVT to disinfect condenser water at the indicated flow rate. UV chamber to be provided with minimum of 2 lamps with less than 2" pressure drop. UV chamber to be of stainless steel construction and provided with manual wiper. Chamber and control panel to be factory mounted on filtration skid and utilize a single point power connection.

L. Purging and Solids Handling

1. Evacuation of separated solids may be accomplished automatically, employing a motorized ball valve with integrally-equipped programming for controlling the frequency and duration of solids purging.

M. Heated Enclosure for outdoor installation

1. The filtration pump station shall be totally enclosed by a modular type heated enclosure. The enclosure shall completely enclose the pump station mounting base and be flush with pump station pad.
2. The pump station enclosure shall consist of the following:
 - a. Side panels, two sets of doors, and roof panels shall be constructed of galvanized steel. Corner posts, center posts and header beams shall be formed from structural galvanized steel. All side and roof panels shall be insulated.
 - b. A header beam shall run from corner post to corner post on all sides of the enclosure. The framework is then attached to the skid utilizing the supplied mechanical hold-downs.
 - c. Each side panel shall have either a corner or center post on each side. Corner and center posts hold side panels in place from behind. Header beams hold side panels in place at the top and front.
 - d. Units shall be provided with a high security door bar lock and lever mechanism that is designed to accept any standard lock.
 - e. One incandescent light fixture shall be mounted at least 54" above the floor. The fixture will be suitable for wet locations and a cage will protect the light bulb. The switch will also be suitable for wet locations and be mounted at the edge of the door giving access to the control cabinet. All wire will be protected inside ½" sealtite flexible conduit.
 - f. A fan shall be incorporated into one fixed side panel. The fan shall have protective screening completely surrounding the blades and self-opening shutters on the outside of the panel. The fan shall draw air from within the enclosure. A self-opening louvered panel shall be placed in a fixed side panel as far from the fan as possible. This louvered panel shall serve as air intake into the enclosure. An industrial thermostat will activate the fan.
 - g. Heat will be required to protect the piping and equipment from exterior temperatures to -0°F and be thermostatically controlled. UP or ETL listed self-regulating wall mounted air heater(s) will be sized to maintain the equipment at +40°F, in accordance with N.F.P.A. 3-3.1.8 & 3-6.1.3.2. Power source shall be protected with a ground fault interrupting receptacle, U.L. 943, NEMA 3R, installed by the factory. field installed heating devices are not acceptable.
 - h. A UL listed single feed breaker panel with 120V step down transformer shall be mounted on the exterior wall of the enclosure and will service the power requirements for the entire filtration skid package, internal mounted light, space heater and ventilation fan. Panel shall meet FCC# 15 and NFPA 70 code standards.
 - i. Filtration skid package shall ship preinstalled and wired from the manufacturer. Side

wall punch outs with inlet and outlet piping shall be provided for ease of installation.

- N. Manufacturers: Culligan, Ecodyne, Griswold, Lakos, PEP Filters, Puriflux, Rosedale.

2.5 WATER-SOFTENER CHEMICALS

- A. Mineral: High-capacity, sulfonated-polystyrene ion-exchange resin that is stable over entire pH range with good resistance to bead fracture from attrition or shock. Resin exchange capacity minimum 30,000 grains/cu. ft. of calcium carbonate of resin when regenerated with 15 lb. of salt.
- B. Salt for Brine Tanks: High-purity sodium chloride, free of dirt and foreign material. Rock and granulated forms are unacceptable.

PART 3 EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

- A. Equipment Mounting:
1. Install water-softener and /water filtration equipment on 4-inch-high housekeeping pad.

3.3 R-SOFTENER INSTALLATION

- A. Install water-softener equipment on concrete bases, level and plumb.
- B. Maintain manufacturer's recommended clearances.
- C. Arrange units so controls and devices that require servicing are accessible.
- D. Anchor mineral and brine tanks and floor-mounting accessories to substrate.
- E. Install brine lines and fittings furnished by equipment manufacturer but not factory installed.
- F. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.
- G. Install water-testing sets on wall adjacent to water softeners.

3.4 RO UNIT INSTALLATION

- A. Install RO unit and storage tank on concrete bases, level and plumb.

- B. Maintain manufacturer's recommended clearances.
- C. Arrange units so controls and devices that require servicing are accessible.
- D. Anchor RO unit and storage tank with pumps to substrate.
- E. Install interconnecting piping and controls furnished by equipment manufacturer but not factory installed.
- F. Install water-testing sets on wall adjacent to RO unit.

3.5 CARTRIDGE - TYPE FILTERS

- A. The first set of the Government's filter elements shall be installed immediately prior to water balancing but after cleaning and flushing of the piping system. Deliver second set over to Government as a future replacement.
- B. Adjust balancing valve for indicated flow.
- C. Provide sufficient clearance above casing for element replacement.
- D. If pump system is operated for temporary heating or cooling during construction, it shall be operated with filter media other Government's sets, but of equal or greater efficiency to those specified. Obtain approval from the Contracting Officer's Representative (COR) for temporary filter prior to installation and use of the system.

3.6 SOLIDS SEPARATOR

- A. Provide full port ball valve in both standard and auxiliary purge lines full size of connection.
- B. Additionally, provide automatic purge system.
- C. Pipe discharge of purge lines to roof drain.
- D. If pump system is operated for temporary heating or cooling during construction, it shall be operated with filter media other Government's sets, but of equal or greater efficiency to those specified. Obtain approval from the COR for temporary filter prior to installation and use of the system.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Make piping connections between HVAC water-softener and water filtration equipment and dissimilar-metal piping with dielectric fittings.
- D. Comply with requirements for backflow preventers required in makeup-water connections to

potable-water systems.

- E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections /with the assistance of a factory-authorized service representative/:
 - 1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing.
 - 3. Place HVAC water-softener and water filtration system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- B. Equipment will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.9 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
 - 1. Periodic field service and consultation.
 - 2. Customer report charts and log sheets.
 - 3. Laboratory technical analysis.
 - 4. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

END OF SECTION 23 25 33

SECTION 23 31 13 - DUCTS AND DUCT ACCESSORIES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Sheet metal ductwork, insulated flexible ductwork, flexible ductwork, smoke detector installation, and leakage testing.
- B. Instrumentation requirements associated with controls, not limited to temperature transmitters, gauge pressure transmitters, differential pressure transmitters, filter differential pressure transmitters, humidity transmitters, damper actuators, air flow stations, shall be per specification sections 25 00 20 70, "Instrumentation".

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound, and Vibration Control
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 07 00 - HVAC Insulation
- G. Section 23 08 16 - Commissioning of HVAC Systems
- H. Section 23 34 16 - Fans
- I. Section 23 37 13 - Air Outlets and Inlets
- J. Section 23 73 13 – Indoor Basic Air Handling Units
- K. Section 23 73 16 – Air Rotation Units
- L. Section 23 73 43 – Outdoor Custom Air Handling Units
- M. Section 28 31 11 – Digital Addressable Fire Alarm System
- N. Section 25 00 00 - Chiller Plant control System
- O. Section 25 00 10 – Hot Water Skid Control System
- P. Section 25 00 20 – Air Handlers Control System

1.3 QUALITY ASSURANCE

- A. For details not specified, such as hangers, elbow construction, offsets, obstruction streamlining, branch connections, dampers, sealing, the following reference applies: Sheet Metal and Air Conditioning Contractors National Association "HVAC Duct Construction Standards, Metal and Flexible," Third Edition, 2005 referred to herein as SMACNA-HVAC.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Statement indicating compliance with SMACNA standards and specified system pressure ratings.
- C. Manufacturer's technical product data, installation instructions and accessories for the following:
1. Fire Dampers.
 2. Access Doors.
 3. Balancing Volume Dampers.
 4. Round Duct and Fittings.
 5. Insulated Flexible Duct.
 6. Sealant Compound.
 7. Airflow Monitors.
 8. Duct Silencers.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Physical Interference: Provide offsets or changes in duct shape required to avoid structural or other interference without additional cost to the Owner.
- B. Ductwork dimensions indicated on the drawings are internal.
- C. System Pressure Rating: Construct systems in accordance with the following pressure rating.

SYSTEM	PRESSURE RATING (INCHES- W.G.)
All Supply Secondary Ductwork (runouts and branches from main ducts)	2
All Return/Exhaust/Secondary Ducts (runouts and branches to main ducts)	(-)2
All Supply Main Ductwork (Equipment connections, risers, main distribution)	3
All Return/Exhaust Main Ducts (equipment)	(-)3

connections, risers, main return/exhaust)	
---	--

PART 2 PRODUCTS

2.1 FITTINGS AND ACCESSORIES

A. Elbows:

1. Provide 90-degree elbows of radius construction wherever space permits and elsewhere of square construction. Construct 90-degree square elbows with double radius turning vanes unless otherwise indicated. If throat radius on curved elbows must be less than duct width, provide full-length metal turning vanes. Provide 3/4-inch trailing edge on turning vanes of 90-degree square elbows wherever elbow is less than one duct perimeter upstream of change in duct size or direction.
2. Where a size change must occur at a square elbow, extend runners from throat to heel and secure vanes on runners parallel with duct sides.
3. Unless otherwise indicated, provide offsets with 30-degree full radius elbows as maximum.

B. Flexible Collars: Provide 6-inch wide neoprene impregnated glass fabric collars between fans and ducts or casings, and wherever ducts cross building expansion joints. Collars shall have flame retardant to have flame spread index not over 25 and a smoke developed index not over 50.

C. Fire Dampers:

1. Fire Damper material shall match the adjacent duct material into which it is being installed.
2. Provide fire dampers in compliance with local and NFPA requirements as to location, installation and design.
3. Dampers shall be dynamic type to fully close under airflow conditions. Each damper shall be factory marked with the words, "For Use in Dynamic Systems."
4. Dampers shall bear UL label in accordance with UL Standard 555, latest edition, for dynamic dampers.
5. Frame: Unless otherwise required, provide dampers with multiple blade or expanding curtain type; fabricated with rolled-formed, galvanized steel for with mitered and interlocking corners.
6. Fire Rating: 1-1/2-hour; frame and damper storage totally recessed out of air stream; resettable from either up or downstream sides. Where installation and rating for dynamic operation requires multiple damper sections, only the intermediate damper storage section may be in the air stream.
7. Mounting Sleeve: Factory or field-installed, galvanized sheet steel gage in accordance with UL listing:
 - a. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
8. Mounting Orientation: Vertical or horizontal as indicated.
9. Blades: Roll-formed, interlocking,
10. Fusible Links: Replaceable, 165 degrees F rated.
11. Multiple blade dampers whose overall size exceeds the maximum single section, require actuators. Provide actuators and associated electrical service as required.

D. Duct Access Door Construction:

1. Duct Access door material shall match the duct material into which it is being installed.
2. SMACNA-HVAC, Fig. 7-2, Door A, Frame 1, Hinge Position 1 for 2-inch w.g. static pressure rating and less.
3. Pressure rating higher than 2-inch w.g. Manufacturer rated for 7-inch w.g. without leakage. Internally protected insulated panel with 1-inch insulation, permanently mounted latches. Removable panels shall be constrained from falling into duct by frame construction or chain secured to frame.

E. Balancing Volume Dampers:

1. Balancing Volume Damper material shall match the duct material into which it is being installed.
2. Pressure Rating 2-inch W.G. (500 Pa) and Less: SMACNA-HVAC, 7-4 A, B, C, 12-inch maximum blade width no internal frame. Fig. 7-15, multi opposed blade larger than 12-inch duct height, 8-inch maximum blade width. Recess frame totally out of airstream. Limit stop penetration into airstream to 1/2-inch. Dampers less than 5 feet upstream of outlets, equivalent to Young Regulator No. 820.
3. Rating Higher than 2-inch W.G.:
 - a. Round: Provide rectangular duct type with pocket recess for frame and unused portions of damper.
 - b. Rectangular: SMACNA HVAC Fig. 7-4 B, 12-inch minimum blade width same as pressure rating 2-inch w.g. and less, except with closed end bearings, Fig. 7-15, multi opposed blade larger than 12-inch duct height, 8-inch maximum blade width same as pressure rating 2-inch w.g. and less, except with closed end bearings.
4. Locate where accessible for adjusting after completion of work. Provide access panels where regulators are concealed. Provide damper regulators equal to "Ventlok" models listed:
 - a. Concealed or Exposed in Unfinished Space: No. 641 ("HiVel" for pressure higher than 2-inch w.g.).
 - b. Exposed in Finished Space: No. 688 ("HiVel" for pressure rating higher than 2-inch w.g.).
 - c. Manufacturers: Ventfabrics, Young Regulator.

F. Low Leakage Type Dampers: Galvanized steel channel frame with galvanized steel airfoil blades, opposed action for multiblade units. Blades shall have edge seals mechanically attached to blades. Damper shall have a leakage rate not exceeding 4 cfm or approved equal per square foot at 1-inch w.g.:

1. Location and additional requirements are specified in Specification 23 73 43, "Outdoor Custom Air Handling Units."
2. Control damper requirements are specified in Specification 23 73 43, "Outdoor Custom Air Handling Units."

G. Instrument Test Holes: Locate where accessible in main or major branch ducts and upstream of smoke detectors to permit measurement of fan air quantities according to ASHRAE Pitot tube method. Locate holes on more than two sides of larger duct if required by available Pitot tube length. Provide holes with 1-inch high Ventlok No. 699 instrument ports.

- H. Plenum Connections: Provide bellmouth type for round ducts connecting to apparatus casings; maximum 20 degrees transition angle for rectangular ducts.
- I. Open End Ducts on Return and Exhaust Systems: Provide 2-inch-high flanges on all four sides of openings, same gage as duct. Provide birdscreen on opening.
- J. Thermometers:
 - 1. Direct Mounting: 5-inch dial, externally calibrated, standard industrial bimetal, with stainless steel stems and cases equal to Weston Models 4503 and 4513. Stem length minimum, one-half the depth of duct; maximum, 24 inches.
 - 2. Where indicating points cannot be conveniently read or temperature correctly sensed, provide mercury filled protected capillary tube for remote mounting.
 - 3. Range for Media Temperatures not Exceeding 100 degrees F: 25 to 125 degrees F except minus 40 to 120 degrees F for outdoor air.
 - 4. Range for Media Temperatures above 100 degrees F, but not exceeding 220 degrees F: 30 to 240 degrees F.
 - 5. Accessories: Provide with flanges and separable brass bushing with insulation extension on insulated ductwork.
 - 6. Manufacturers: Ashcroft, Marsh, Marshalltown, Moeller, Taylor, Tel Tru, Terrice, U.S. Gage, Weiss, Weksler, Weston, Winters.
 - 7. For temperature transmitter requirements see Specification 25 00 20 70," Instrumentation"

2.2 RECTANGULAR DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER

- A. G90 coated, Galvanized steel sheets, reinforcing and companion angles, and hangers. Provide metal specification, gages and construction of seams, joints and reinforcing according to SMACNA-HVAC.
- B. Stainless Steel Sheets: Type 304, cold rolled, annealed, sheet. Exposed surface finish is to be No. 2B. Provide metal specification, gages and construction of seams, flanged and gasketed joints and reinforcing according to SMACNA HVAC.

2.3 RECTANGULAR DUCTWORK - PRESSURE RATED HIGHER THAN 2-INCH W.G.

- A. G90 coated, Galvanized steel sheets, reinforcing, galvanized tie rods and hangers. Metal specification, gages and construction of seams, joints, and reinforcing according to SMACNA-HVAC.
- B. Stainless Steel Sheets: Type 304, cold rolled, annealed, sheet. Exposed surface finish 2B. Provide metal specification, gages and construction of seams, flanged and gasketed joints and reinforcing according to SMACNA HVAC:
 - 1. Accessories: Vanes, runners, dampers, and other accessories shall be constructed of same material as duct.
 - 2. Finish: Surface including angles and hangers to match that of stainless-steel equipment to which ductwork is attached.

2.4 ROUND DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER

- A. G90 coated, Galvanized steel ducts, reinforcing, joining angles and hangers. Metal specification, gages and construction of ducts according to SMACNA-HVAC.
- B. Stainless Steel Sheets: Type 304, cold rolled, annealed, sheet. Exposed surface finish 2B. Provide metal specification, gages and construction of seams, flanged and gasketed joints and reinforcing according to SMACNA HVAC.
- C. Unless otherwise indicated, 90-degree elbows shall be 5 sections or die formed; and 90-degree branch connections shall be long or bell formed conical.
- D. Manufacturers: Spiral conduit and fittings - Eastern Sheetmetal, Hamlin, Lindab, McGill Airflow Corp., Monroe, Semco.

2.5 ROUND DUCTWORK - PRESSURE RATED HIGHER THAN 2-INCH W.G.

- A. G90 coated, Galvanized steel ducts, reinforcing, joining angles and hangers. Metal specification, gages and construction of ducts and fittings according to SMACNA-HVAC.
- B. Stainless Steel Sheets: Type 304, cold rolled, annealed, sheet. Exposed surface finish 2B. Provide metal specification, gages and construction of seams, flanged and gasketed joints and reinforcing according to SMACNA HVAC.
- C. Fittings: Unless otherwise indicated, 90-degree elbows shall be 5 sections or die formed; and 90-degree branch connections shall be long or bell formed conical.
- D. Manufacturers: Spiral conduit and fittings - Eastern Sheetmetal, Hamlin, Lindab, McGill Airflow Corp., Monroe, Semco.

2.6 EXHAUST DUCTWORK

- A. Unless otherwise indicated, the requirements for minus 2-inch w.g. pressure duct construction apply.
- B. Material (except as otherwise indicated): Galvanized steel sheets, reinforcing and hangers.
- C. Flanged Joints: Provide flanged and gasketed watertight joints on hoods or equipment.
- D. Shower Exhaust: Construct ducts exhausting from shower rooms to point of connection to main exhaust ducts as indicated, of Type 304 stainless steel sheets with galvanized reinforcing and hangers.

2.7 RECTANGULAR DUCT LINING

- A. Two -inch thickness 1.5 pcf density glass fiber blanket with smooth coated or matte surface shall conform to ASTM C1071 and NFPA 90A requirements.
- B. Corrosion resistance shall pass ASTM C665 test and meet ASTM C1071 up to 6000 fpm at 250 degrees F.

- C. Water vapor sorption shall be less than 3 percent by weight in accordance with ASTM C1104.
- D. Linings shall comply with the Erosion Test Method described in UL-181. Linings, including coatings and adhesives, shall have a flame spread index of 25 or less and a smoke developed index of 50 or less as determined by an independent testing laboratory in accordance with NFPA 255, as required by NFPA 90A. Coatings and adhesives applied in field shall be non-flammable in wet state.
- E. Impregnate lining surface with biocide meeting no-growth fungi and bacteria results when tested in accordance with ASTM G21-90 and ASTM G22-90.
- F. Manufacturers: Certainteed ToughGard-Rigid Liner Board, Johns-Manville Permacote, Knauf E-M, Owens-Corning.

2.8 ROUND DUCT LINING

- A. Prefabricated duct and fittings to conform to the requirements of round ductwork with 1-inch fiber lining with perforated zinc coated inner liner. Protect internal lining with film of Tedlar or neoprene to preclude particle shedding.
- B. Manufacturers: McGill Airflow Corp., Semco, Spira-Matic.

2.9 FLEXIBLE DUCT

- A. Spiral wound metal reinforced coated glass fabric, equal to Thermaflex S-TL.
- B. Duct shall be rated for 12-inch w.g. positive, 2-inch w.g. negative pressure, 0 to 180 degrees F continuous temperature, and 4000 fpm air velocity.
- C. Manufacturers: Genflex, Thermaflex, Wiremold.

2.10 INSULATED FLEXIBLE DUCT

- A. Spiral wound metal reinforced coated glass fabric, factory insulated with 1-inch, 3/4-pound density insulation with flexible outer vapor barrier, equal to Thermaflex M-KC.
- B. Duct shall be rated for 10 inch-w.g. positive, 2-inch w.g. negative pressure, 0 to 180 degrees F continuous temperature, and 4000 fpm air velocity.
- C. Manufacturers: Flexmaster, Genflex, Thermaflex, Wiremold.

2.11 GASKETS

- A. 3M Company EC-1202 tape sealer. Minimum size and thickness 1 by 1/8-inch.

2.12 SEALING COMPOUND

- A. Childers CP-146, McGill Airseal Corp. "United Duct Sealer," Foster 32-194, Hardcast, Inc.

2.13 AIRFLOW MONITORS

- A. Airflow monitor requirements shall be per requirements of Specification 25 00 20 70, "Instrumentation"

2.14 DUCT MOUNTED SMOKE DETECTORS

- A. Smoke detectors are furnished under Section 28 31 11, "Digital, Addressable Fire Alarm System".
- B. Provide accessories including access doors, test ports, duct recess, etc., to install detectors as detailed on the drawings.

2.15 DUCT SILENCERS

- A. See Specification 23 33 30, "Duct Silencers"

PART 3 EXECUTION

3.1 GENERAL

- A. All indoor/outdoor ductwork either exposed or insulated/jacketed associated with Air Handling units serving the Clean Room shall be stainless steel.
- B. All ductwork conveying scrap destruction material shall be galvanized, 18 gauge, flanged and gasketed, all welded, buffed, polished and tag tree. Elbows shall be galvanized, 14 gauge, galvanized, flanged and gasketed, all welded, buffed, polished tag tree, 5-gore, long radius type.
- C. All other outdoor ductwork exposed or insulated/jacketed shall be stainless steel.
- D. All other indoor ductwork shall be galvanized.

3.2 FITTINGS AND ACCESSORIES

- A. Provide duct accessories of materials suited to duct materials; use galvanized steel accessories in galvanized steel ducts, stainless steel accessories in stainless steel ducts, and aluminum accessories in aluminum ducts.
- B. Vibration: Brace or reinforce ducts where necessary to overcome vibration, buckling or breathing.
- C. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators. For fans developing static pressures of 5-inch w.g. and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

D. Fire Dampers:

1. Install in accordance with their UL listing and equip with a steel sleeve or adequately sized frame installed so that disrupting of attached ductwork will not impair operation of the damper.
2. Sleeves or frame shall have perimeter mounting angles attached on both sides of the wall or floor openings.
3. Adjust fire and smoke dampers for proper action.
4. Connect wiring, where required, in accordance with Division 16.

E. Balancing Volume Dampers:

1. Install a minimum of two duct widths from air outlet or inlet device.
2. Mark balanced position.
3. Elevate dial to face of insulation.
4. Dampers in lined ducts shall avoid damage to and erosion of duct liner.

F. Thermometers: Install in outdoor, return, and supply air ductwork at air handling units and elsewhere as indicated.

G. Instrument Test Holes: Repair exposed edge of lining where installed in lined ductwork.

H. Install airtight duct access doors in casings, plenums, and ducts to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:

1. On both sides of duct coils.
2. Downstream from volume dampers, turning vanes, and equipment.
3. Adjacent to fire dampers, providing access to reset or reinstall fusible links.
4. To plenums, and ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available, otherwise locate on bottom of ducts.
6. Install the following sizes for duct-mounting, rectangular access doors:
 - a. One-Hand or Inspection Access: 8 by 5 inches.
 - b. Two-Hand Access: 12 by 6 inches.

I. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
2. Two-Hand Access: 10 inches in diameter.

3.3 RECTANGULAR DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER

- A. Construct ducts true to indicated dimensions, straight and smooth on inside with neatly finished airtight joints.
- B. Where rigid board insulation is applied, do not use cross break or bead construction.
- C. Construct the sides of a section of duct of gage specified for its maximum dimension.

- D. Seal seams and joints in outdoor ductwork with sealing compound protected with weather resistant tape.
- E. Seal transverse joints, fitting connections and snaplock seams in indoor ductwork with sealing compound and tape.

3.4 RECTANGULAR DUCTWORK - PRESSURE RATED HIGHER THAN 2-INCH W.G.

- A. Construct ducts true to indicated dimensions, straight and smooth on inside with neatly finished airtight joints.
- B. Seal seams, openings, and joint corners with sealing compound according to SMACNA-HVAC, Seal Class A, Paragraph S1.9. Clean and paint welds and threads with zinc dust paint.

3.5 ROUND DUCTWORK - PRESSURE RATED 2-INCH W.G. AND LOWER

- A. Clean and paint welds with zinc dust paint. Seal transverse joints, fitting connections and snaplock seams in indoor ductwork with sealing compound and tape.

3.6 ROUND DUCTWORK - PRESSURE RATED HIGHER THAN 2-INCH W.G.

- A. Clean and paint welds with zinc dust paint.
- B. Seal seams, openings, and joints with sealing compound according to SMACNA-HVAC, Seal Class A, Paragraph S1.9.

3.7 EXHAUST DUCTWORK

- A. Construct ducts true to indicated dimensions, straight and smooth on inside with neatly finished airtight joints.
- B. Exposed Duct Connecting to Equipment:
- C. Weld seams and joints by tungsten inert gas method. Use automatic or skip welding, clamping to prevent warpage or distortion. Use Type 308 wire to fill voids and depressions. Spot-weld angles to ducts.
- D. Clean both surfaces of welds to remove heat discoloration and weld scale using a special chemical abrasive made especially for this purpose. Do not wire brush or use steel wool. Where exposed, grind and polish welds, leaving no visible evidence of joining.
- E. Shower Exhaust: Seal bottom and for 2-inch along side panels vertically up from bottom to make watertight joint. Pitch duct to drain through shower room grille.

3.8 INSULATED FLEXIBLE DUCT

- A. Provide on connection to round neck supply air ceiling diffusers.

- B. Runs of insulated flexible duct shall not to exceed five feet in length.
- C. Install without kinks and compressions. Support duct with minimum 1-inch wide band hangers to avoid sagging. Supports shall conform to SMACNA Fig. 3-10.
- D. Provide bends with throat radius not less than outside diameter of insulated flexible duct.
- E. Provide duct elbow support at locations where an elbow connection is provided.
- F. Seal insulation at ends and other openings to maintain continuity of vapor barrier. Secure joints with pressure sensitive tape and clamps. Insert high-density sections of insulation between vapor barriers and duct under clamps to maintain insulation thickness.
- G. Install in accordance with manufacturer's instructions and recommendations.

3.9 GASKETS

- A. Overlap gaskets at corners and ends.

3.10 SEALING COMPOUND

- A. Follow manufacturer's recommendations. If necessary to achieve an airtight joint, additionally apply duct tape to wet sealant compatible with the sealer used. Allow adequate curing time before pressurizing system.

3.11 AIRFLOW MONITORS

- A. Install static pressure sensing stations in ductwork where shown on drawings. Locate upstream and downstream of fittings and components as recommended by manufacturer.
- B. Install outdoor air measurement and monitor controller where shown on drawings. Install in accordance with manufacturer's recommendations.
- C. Identify each unit with permanent label listing model number, size, area, and capacity.
- D. Provide wiring between the sensor and the electronics. Use UL plenum rated cable.

3.12 DUCT MOUNTED SMOKE DETECTORS

- A. Install smoke detectors to control shutdown of air handling system.
- B. Locate where indicated on the drawings.
- C. Install in accordance with smoke detector supplier's instructions and recommendations.

3.13 TESTING

- A. Test 2-inch w.g. and higher pressure (minus 2 inches and greater negative pressure) rated ductwork for leaks.
- B. Test setup and procedure shall be generally in accordance with SMACNA HVAC Air Duct Leakage Test Manual, First Edition, 1985, with the following exceptions:
- C. Test each duct section at rated pressure.
- D. Seal leaks and openings and retest after sealer has cured.
- E. After completing successful testing of a duct section, demonstrate duct tightness to Contracting Officer's Representative by repeating test.

END OF SECTION 23 31 13

SECTION 23 33 00 – DUCT SILENCERS

PART 1 GENERAL

- 1.1 Drawing Designation: SL-1R, 2R, 3R, and 4R, SL-1S, 2S, 3S, and 4S.
- 1.2 Basis-of-Design Product: Vibro-Acoustics.
- 1.3 Alternate manufacturers must request and obtain written approval by the Engineer to bid the project at least 10 days prior to the bid due date. As a condition of pre-approval, alternate manufacturers must submit to the Engineer a minimum of twenty (20) different HVAC silencer test reports. Each report shall be for a silencer tested in full accordance with the ASTM E-477-13 silencer test standard in an aero-acoustic test facility which is NVLAP accredited for the ASTM E477-13 standard. Each test shall have been conducted within the last 12-month period. A copy of the laboratory's NVLAP accreditation certificate must be included with the submitted reports. Any changes to the specifications must be submitted and approved in writing by the Engineer at least 10 days prior to the bid due date.
- 1.4 If products other than those of the basis of design manufacturer are supplied on the project, the purchasing contractor assumes full performance, project schedule and monetary responsibility for meeting the project noise criteria, including any retrofit work that may be required
- 1.5 SUBMITTALS
- A. Performance Data:
1. Silencer manufacturer to provide submittal drawings detailing all duct silencer data specified in the mechanical drawing schedule.
- B. Source quality-control reports:
1. Silencer manufacturer to provide a copy of their laboratory NVLAP accreditation certificate for the ASTM E477-13 test standard with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.
- 1.6 QUALITY ASSURANCE
- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Silencer performance must have been substantiated by laboratory testing in a duct-to-reverberant room test facility according to ASTM E477-13. The test facility must provide for air-flow in both directions through the test silencer. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption. The aero-acoustic laboratory must be currently NVLAP accredited for the

ASTM E477-13 test standard.

- C. Silencer manufacturer shall provide a written test report by a third party organization showing silencer assemblies have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.

1.7 EXTRA MATERIALS

- A. None required for silencers.

PART 2 PRODUCTS

2.1 DUCT SILENCERS

A. General Requirements:

1. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer.
2. Silencer inlet and outlet connection dimensions must be equal to the duct sizes shown on the drawings. Duct transitions at silencers are not permitted unless shown on the contract drawings.
3. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in other sections are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
4. All casing seams and joints shall be lock-formed and sealed or stitch welded and sealed except as noted in Section G below, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
5. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.
6. Fire-Performance Characteristics: Silencer assemblies, including acoustic media fill, Vi-bar™ film liner, sealants, and acoustical spacer, shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84, NFPA 255 or UL 723.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

- B. Rectangular Elbow Silencers including models RENM: Outer casing shall be stainless steel, type 304, cold rolled annealed sheet steel, 18 gauge. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.

- C. Transitional Silencers including models TNM: Outer casing shall be stainless steel, type 304,

cold rolled annealed sheet steel, 22 gauge. Transitioning shall occur internal to the silencer such that the height of the gap or air passage is uniformly changing with the length of the splitters.

- D. Inner perforated metal liner: stainless steel, type 304, cold rolled annealed sheet steel.
 - 1. Rectangular Silencers: 26 gauge.
 - 2. Rectangular Elbow Silencers: 22 gauge.
 - 3. Transitional Silencers: 22 gauge.
- E. Principal Sound-Absorbing Mechanism:
 - 1. No-Media silencers:
 - a. Models RENM shall not contain absorptive media of any kind. Attenuation shall be achieved with controlled impedance membranes and broadly tuned resonators.
- F. HTL Casings: Where indicated on the silencer schedule, silencers shall have high transmission loss (HTL) walls externally applied and completely sealed to the silencer casing by the silencer manufacturer to assure quality-controlled transmission loss. The HTL walls shall consist of media, airspace, mass and outer protective metal skin, as required, to obtain the specified room noise criteria. Standard acoustical panels will not be accepted as HTL walls. If requested by the Engineer, breakout noise calculations for each air handling and fan system shall be provided with the silencer submittal to ensure compliance with the room noise criteria. Breakout noise calculations shall be based on the sound power levels of the specified equipment.
- G. Special Construction:
 - 1. Where noted on the silencer schedule, silencers shall have 16-gauge casing, continuously welded.
 - 2. Where indicated on the silencer schedule, silencers shall have RF filters integral to the silencer. Performance shall be 100 dB at 1 MHz Pressure drop shall be included in overall silencer pressure drop. RF filter shall be located such that it cannot be bypassed.
 - 3. Where indicated on the silencer schedule, provide a non-conductive section in the silencer casing at the end of the silencer next to the room wall, and provide a minimum of 10" x 10" inspection port in the silencer casing next to the wall. These features shall not compromise the composite HTL casing of the silencer.
 - 4. Where indicated on the silencer schedule, provide security bars running at 6" centers both ways inside the silencer casing to prevent ingress through the silencer.
- H. Accessories:
 - 1. Access Doors: Where indicated on the silencer schedule, silencers shall be supplied with an access door(s) to permit fire damper service. Access doors shall be supplied as an integral part of the silencer by the silencer manufacturer. Where HTL walls are also supplied, the access doors shall not reduce the effectiveness of the HTL walls.
 - 2. Shipping Protection: Silencers shall be shipped with factory-installed end caps to prevent contamination during shipping.
 - 3. Airflow Measuring Devices: Where indicated on the silencer schedule, silencers shall have airflow measuring devices factory installed as part of the silencer assembly.
- I. Source Quality Control: Test according to ASTM E 477-06a.

1. The manufacturer shall test the silencer(s) as indicated in the silencer schedule. The engineer shall be notified of the test date at least two weeks in advance and the test may be witnessed by the engineer. Test shall show compliance with the project criteria and is subject to engineer approval.
2. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance must have been substantiated by laboratory testing according to ASTM E477-13 and so certified when submitted for approval. The aero-acoustic laboratory must be NVLAP accredited for the ASTM E477-13 test standard. A copy of the accreditation certificate must be included with the submittals. Data from non-NVLAP accredited test facilities will not be accepted.

J. Capacities and Characteristics:

1. See duct silencer performance schedule on mechanical drawings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install silencer according to manufacturer's written installation instructions.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Ensure duct silencers are installed with airflow arrows in direction of airflow.

END OF SECTION 23 33 00

SECTION 23 34 16 - FANS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Fans and fan performance criteria for air distribution, ventilation and exhaust systems. Fan performance criteria for fan application in air handling units.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound, and Vibration Control
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting and Balancing
- F. Section 23 08 16 - Commissioning of HVAC System
- G. Section 23 31 13 – Ducts and Duct Accessories
- H. Section 23 37 13 - Air Outlets and Inlets
- I. Section 23 73 13 13 – Indoor Basic Air Handling Units
- J. Section 23 73 13 – Air Rotation Units
- K. Section 23 73 43 – Outdoor Custom Air Handling Units
- L. Section 25 00 00 – Chiller Plant Control System
- M. Section 25 00 10 – Hot Water Skid Control System
- N. Section 25 00 20 – Air Handlers Controls System
- O. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.
- B. Fans shall comply with performance requirements and shall be licensed to use AMCA Certified Rating Seal for sound and air pressure.

- C. Operating Limits: Classify according to AMCA 99.
- D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Manufacturer's technical product data, installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimension of components for each type of product indicated and shall include the following:
 - 1. Certified fan performance curves with system specified rating and operating conditions indicated on the curve.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories. Brake horsepower with motor NEMA service factor calculations shall be provided.
 - 4. Fan class rating.
 - 5. Fan curve with system curve through indicated minimum system static pressure for fans with variable speed drives.
 - 6. Roof curb data and dimensions.
 - 7. Operation and Maintenance Data: Include in emergency, operation and maintenance manuals.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed in this Section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials and equipment specified in this section with performance requirements as stated herein or on the drawings.

1.7 WARRANTY

- A. Provide with manufacturers standard warranty.

PART 2 PRODUCTS

2.1 FANS – GENERAL REQUIREMENTS

- A. Provide fans complete with motors and drives. Type, capacity, wheel diameter, horsepower, special construction features and other requirements are scheduled on the drawings.

- B. Equip belt driven fans with matched set of belts and belt guards. Belt guards shall be constructed to conform to OSHA construction requirements and have provisions for speed measurement of motor and fan without removal of the guard. Balance dynamically fan pulleys over 4-inch face width and 18-inch diameter. Equip fans with motors 20-horsepower and smaller with adjustable pitch drive and conventional V-belts. For fans with larger motors provide fixed pitch drive for speed designated by fan manufacturer. Provide additional pulleys and belts to adjust speed required for final air balance.
- C. The first critical speed of the fan shaft, wheel, and bearing arrangement shall be at least 125 percent of the maximum cataloged speed of the fan assembly.
- D. Fans shall be (1) catalog rated for 15 percent greater static pressure than specified at specified air volume, (2) selected so that the specified air volume is greater than that at the apex of the fan pressure volume curve, and (3) selected to provide stable operation down to 85 percent of design volume operating at the required speed for the specified conditions. Submit fan curves to indicate all of these conditions as stated below. Brake horsepower at specified duty for airfoil and backward inclined bladed centrifugal fans shall not exceed 78 percent of motor nameplate horsepower times the NEMA service factor and for forward curved bladed centrifugal fans shall not exceed 70 percent of motor nameplate horsepower times the NEMA service factor.
- E. Balance fans statically and dynamically for maximum rated speed.
- F. Fans shall have AMCA certified ratings for sound and air pressure. Submit for review pressure, volume and horsepower curves for all fans. Curves shall indicate fan class ratings and unstable operation area:
 - 1. For fans with variable speed drives, the fan curves shall indicate operation on system curve through indicated minimum system static pressure required. Indicate any critical frequency on fan submittal.
- G. Bearings shall have a minimum AFBMA L-10 life of 80,000 hours based on maximum cataloged speed for class indicated.

2.2 UTILITY SET

- A. Drawing Designation: 04 10 EA EAF-1.1, 1.2, 1.3 and 1.4, 04 10 EA EAF-2 and 3.
- B. Utility set, belt driven with factory assembled backwardly inclined bladed wheel centrifugal scroll-housed, belt-driven fan and drive equal to Greenheck USF
 - 1. Provide with the following:
 - a. Continuously welded heavy gauge scroll construction.
 - b. Adjustable motor base.
 - c. Drain connection.
 - d. Weatherproof hood Drive belt guard.
 - e. Scroll access door.
 - f. Piezometer ring at inlet of fan. Fan manufacturer shall pair the correct transmitter with the ring for reading by the building automation system.
 - g. Outlet screen.

- h. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating.
- C. Select drives for 1.2 service factor. Furnish spare set of belts.
- D. Manufacturers: Acme, Bayley, Greenheck, Jenco Fan Co., Loren-Cook, PennBarry, Twin City.

2.3 CENTRIFUGAL ROOF EXHAUST

- A. Drawing Designation: 04 10 EA EAF-4, 5, 6, and 8.
- B. Centrifugal power roof ventilator equal to Greenheck G direct drive.
- C. Provide with the following:
 - 1. Kynar (or equal) coated spun aluminum housing, removable for access to fan and drive with wiring channel.
 - 2. Aluminum bird screen.
 - 3. Hinged sub-base.
 - 4. Non-overloading fan with ventilated motor compartment, shaft seal, disconnect switch factory wired to motor, integral fan and motor vibration isolators. Motor and drive in ventilated compartment, out of main air stream.
 - 5. Provide prefabricated 18 gage aluminum roof curb with built-in cant strip, 2-inch minimum thickness internal insulation, inside vapor barrier cover, isolation pads.
- D. Manufacturers: Acme, Greenheck, Jenco Fan Co., Loren Cook, PennBarry, Twin City.

2.4 CENTRIFUGAL UPBLAST ROOF EXHAUST

- A. Drawing Designation: 04 10 EA EAF-7
- B. Centrifugal upblast power roof ventilator equal to Greenheck CUE direct drive,
- C. Provide with the following:
 - 1. Kynar (or equal) coated aluminum housing, removable for access to fan and drive, with wiring channel.
 - 2. Non-overloading aluminum fan, screw adjustment of belt tension, disconnect switch factory wired to motor. Motor and drive in ventilated compartment out of main air stream.
 - 3. Provide prefabricated aluminum curb with built-in cant, internally insulated, inside aluminum vapor barrier cover.
- D. Manufacturers: Acme, Greenheck, Jenco Fan Co., Loren Cook, PennBarry.

2.5 AXIAL FANS

- A. Drawing Designation: 04 00 OA SAF-1
- B. Axial fan equal to Greenheck AX direct drive,

C. Provide with the following:

1. Continuously welded heavy gauge steel.
2. Permatector coating – Concrete Gray-RAL 7023, Fan and Attached Accessories.
3. Inlet and outlet flanges with mounting holes.
4. Corrosion resistant fasteners.
5. Motor support rigidly formed and welded to the casing.
6. Cast aluminum airfoil blade and hub - Manually adjustable blade pitch.
7. Totally enclosed, air over motor with Class B or F insulation, double shielded bearings, external grease fittings with pressure relief, conduit box on casing with lead wiring to motor enclosed in conduit. Motor shall be aligned on support legs in milled recesses.
8. Fan and motor selection shall permit not less than 10 percent plus or minus adjustment from design volume following the resistance curve for the design pressure volume conditions. Brake horsepower at peak of curve for design blade setting shall not exceed 85 percent of the NEMA nominal (not air over) motor rating for the class of insulation employed and 40 degrees C ambient.

D. Manufacturers: Acme, Greenheck, Loren Cook, PennBarry.

2.6 DUCT MOUNTED IN-LINE CENTRIFUGAL FANS

A. Drawing Designation: 04 02 EA EAF-1, 2, and 3, 04 03 EA EAF-1, 2 , and 3.

B. Duct mounted in-line centrifugal fan equal to Greenheck SQ direct drive with:

1. Square housing constructed of galvanized steel or steel with enamel or epoxy paint finish.
2. Duct mounting collars.
3. Removable or hinged access door(s).
4. Aluminum fan wheel with backward inclined flat or air foil blades.
5. Venturi inlet cone.
6. Motor and drive isolated from airstream.
7. Steel support brackets.
8. Removable 1/2-inch mesh galvanized steel inlet guard.

C. Manufacturers: Acme, Greenheck, Jenco Fan Co., Loren Cook, PennBarry.

PART 3 EXECUTION

3.1 FANS

- A. Lubricate bearings for extended shutdown or storage and rotate shafts every four weeks until fans are put into permanent operation. Verify lubrication for bearings and other moving parts prior to fan startup.
- B. Bolt fans securely to bases, supports or curbs. Secure prefabricated curbs to roof deck.
- C. Install centrifugal fans level and plumb.

- D. Support floor-mounted fan units using vibration control devices as specified in Section 23 05 48, "Mechanical Sound, and Vibration Controls." Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
- E. Install floor-mounted fan units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- F. Support suspended fan units from structure using threaded steel rods, unit mounted suspension clips, and vibration-control devices specified in Section 23 05 48, "Mechanical Sound, and Vibration Controls."
- G. Install fan units with clearances for service and maintenance.
- H. Install ducts adjacent to fans to allow for service and maintenance of fans.
- I. Verify that shipping, blocking, and bracing are removed.
- J. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- K. With fan drive disconnected from wheel, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation after electrical wiring is connected to the motor.
- L. Align and adjust belt tension in accordance with equipment manufacturer's recommendations.

END OF SECTION 23 34 16

SECTION 23 37 13 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Air distribution diffusers, registers and grilles, with application for air outlets and inlets.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 93 - Testing, Adjusting, and Balancing
- D. Section 23 08 16 - Commissioning of HVAC System
- E. Section 23 31 13 - Ducts and Duct Accessories
- F. Section 23 34 16 - Fans
- G. Section 23 73 13 - Indoor Basic Air Handling Units
- H. Section 23 73 16 - Air Rotation Units
- I. Section 23 73 43 – Outdoor Custom Air Handling Units

1.3 QUALITY ASSURANCE

- A. Diffusers, Registers and Grilles: Test and rate in accordance with ASHRAE Standard 70 and AHRI Standard 890.

1.4 SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods."
- B. Statement indicating compliance with ASHRAE and AHRI standards.
- C. Manufacturer's technical product data, installation instructions and accessories:
 - 1. Diffusers.
 - 2. Registers.
 - 3. Grilles.

1.5 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Coordinate with ceiling, floor, and wall construction and materials.
- B. Coordinate with lights, speakers, sprinklers, and other ceiling elements.

PART 2 - PRODUCTS

2.1 DIFFUSERS

- A. Factory-fabricated steel, stainless steel or aluminum with fixed or adjustable air discharge pattern as indicated.
- B. Unless otherwise indicated, provide removable internal parts including the volume regulators and each velocity equalizing device.
- C. Factory-fabricated opposed-blade, gang-operated volume regulator with accessible operator and removable key, unless indicated otherwise.

2.2 REGISTERS

- A. Factory-fabricated steel or aluminum with face-operated, opposed-blade, volume-control damper.

2.3 GRILLES

- A. Factory-fabricated steel or aluminum without volume-control damper.

2.4 DAMPER REMOTE CONTROL

- A. Provide concealed, remote control damper operator equal to Young Regulator 270-301 for concealed dampers or dampers located above gypsum ceilings.

2.5 OUTLET/INLET TYPE

- A. Air delivery, performance, noise level, function, and type suitable for the duty intended and equal in these respects to the following:
 - 1. Square and Rectangular Louvered Faced Ceiling Diffusers:

- a. Type D-1: Titus TDC steel square or rectangular ceiling mounted diffuser with 1, 2, 3, or 4-way blow pattern as indicated. Removable core and fixed horizontal air pattern held tight to the ceiling, and complete with straightening grid round duct adapter, anti-smudge ring, snap-in core continuous gasket and baked white enamel finish. Frame suitable for mounting in the type of ceiling in which the diffuser is installed.
 - b. Type D-2: Titus TDC, extruded aluminum, square or rectangular ceiling mounted diffuser with 1, 2, 3, or 4-way blow pattern as indicated. Removable core and fixed horizontal air pattern held tight to the ceiling, and complete with straightening grid, round duct adapter, anti-smudge ring, snap-in core, continuous gasket and baked white enamel finish. Frame suitable for mounting in the type of ceiling in which the diffuser is installed.
 - c. Type D-3: Price, FRFDSS, panels with adjustable stainless steel volume damper, perforated center section distribution plate, sub-duct for connection to supply ductwork. Ceiling panel plenum constructed of stainless steel. Distribution faceplate constructed of aluminum. Standard Mill Finish and suitable for mounting in the type of ceiling in which the diffuser is installed.
 - d. Type D-4: Price, FRFD, panels with adjustable steel volume damper with baked on powder coat finish, perforated center section distribution plate, sub-duct for connection to supply ductwork. Ceiling panel plenum constructed of steel. Distribution faceplate constructed of aluminum. Finished in baked white enamel and suitable for mounting in the type of ceiling in which the diffuser is installed.
 - e. Type D-5: Titus TMR round ceiling diffuser fully adjustable cones, one-piece flange, positive latch and linkage arrangement to permit removal of cones, continuous gasket damper-grid extractor, straightening grid, anti-smudge ring, and duct ring for exposed duct application. Constructed of steel with baked white enamel finish.
 - f. Type D-6: Titus PAS square or rectangular perforated face, ceiling mounted steel diffuser with 1, 2, 3, or 4-way blow pattern as indicated. Adjustable core, complete with round neck adapter, continuous gasket and baked white enamel finish. Frame suitable for mounting in the type of ceiling in which the diffuser is installed
2. Supply-Air, Side-Wall Registers:
 - a. Type R-1: Titus 300 R vertical face, double deflection steel register with individually adjustable front and rear vanes set on 3/4-inch centers. Unit shall be complete with plaster frame (if indicated), and phosphate coating and baked white enamel finish.
3. Return or Exhaust Air, Side-Wall Registers, Steel Construction:
 - a. Type R-2: Titus 350 R vertical face, steel register with 35-degree stationary deflecting vanes set on 3/4-inch centers. Complete with opposed-blade damper, continuous gasket, and phosphate coating and baked white enamel finish and border suitable for mounting in the type of ceiling in which the register is installed.
 - b. Type R-3: Titus 350 FL, vertical face, aluminum register with 35-degree stationary deflecting vanes set on 3/4-inch centers. Complete with plaster frame (if indicated), continuous gasket, and phosphate coating and baked white enamel finish and border suitable for mounting in the type of ceiling in which the register is installed.
4. Return or Exhaust Air, Side-Wall Grilles, Aluminum Construction:
 - a. Type G-1: Titus 350 F horizontal face, aluminum grill with 0 degrees stationary vanes set on 3/4-inch centers. Complete with flat 1-1/4-inch margin frame, continuous gasket, and metallic gray finish.

5. Return or Exhaust Air, Side-Wall Grilles, Steel Construction:

- a. Type G-2: Titus 350 F horizontal face, steel grill with 0 degrees stationary vanes set on 3/4-inch centers. Complete with flat 1-1/4-inch margin frame, continuous gasket, and metallic gray finish.

6. Square and Rectangular Perforated Faced Return or Exhaust Air Grilles

- a. Type G-3: Titus PAR square or rectangular-perforated face, ceiling mounted steel return or exhaust air grille, as indicated. Complete with round neck adapter, continuous gasket and baked white enamel finish. Frame suitable for mounting in the type of ceiling in which the diffuser is installed.

B. Manufacturers:

1. All Types: Anemostat, Carnes, Krueger, Metalaire, Nailor, Price, Titus, Tuttle & Bailey.

- a. Type D-3 and D-4 diffusers may be provided with non-integral dampers if not available from the manufacturer as an option to be an integral part of the diffuser.

PART 3 - EXECUTION

3.1 DIFFUSERS, REGISTERS, GRILLES

- A. Provide diffusers, registers, and grilles to distribute the quantity of air specified evenly over the intended space without causing dead spots or air velocities exceeding 50 fpm in the occupied zone.
- B. Coordinate location with lighting and ceiling pattern. Perform minor duct modifications to suit.
- C. Add internal baffles where necessary to avoid drafts due to air impingement on nearby partitions, columns, etc.
- D. The installing contractor shall examine all openings, mechanical and electrical work, and adjoining and adjacent construction to receive diffusers and plaster frames prior to commencing this work.
- E. The installing contractor shall field verify that the rough hard ceiling opening dimensions are as indicated within manufacturer's submittals. Hard ceiling conditions shall be plumb and level and ready to receive the plaster frames or framing sections. Openings not acceptable for installation shall be corrected by the appropriate contractor until conditions are satisfactory to installing contractor.

END OF SECTION 23 37 13

SECTION 23 37 23 - HVAC GRAVITY VENTILATORS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Hooded rectangular round penthouse for intake relief air.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 93 - Testing, Adjusting, and Balancing
- D. Section 23 08 16 – Commissioning of HVAC System
- E. Section 23 31 13 - Ducts and Duct Accessories
- F. Section 23 34 16 - Fans

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For gravity ventilators.
 - 1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
 - 2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

1.4 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.5 SOURCE QUALITY CONTROL

- A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

PART 2 PRODUCTS

2.1 FABRICATION

- A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.
- B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
- C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.
- D. Fabricate supports, anchorages, and accessories required for complete assembly.
- E. Perform shop welding by AWS-certified procedures and personnel.

2.2 HOODED VENTILATORS

- A. Drawing Designation: 04 EA VENT-1, 2 AND 3, 04 10 OA VENT-1 AND 2.
- B. Acceptable Manufacturers, Greenheck Fan Corporation, Loren Cook Company, PennBarry; division of Air System Components.
- C. Construction:
 - 1. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than 0.063-inch- thick base and 0.050-inch- thick hood; suitably reinforced.
 - 2. Insulation: None.
 - 3. Insect Screening: Aluminum, 18-by-16 mesh wire.
- D. Dampers:
 - 1. Location: Curb damper tray.
 - 2. Control: As scheduled on drawings.
 - 3. Tray: Provide damper tray or shelf with opening inches less than interior curb dimensions indicated.

2.3 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.
- D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
 2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
- E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.
- B. Secure gravity ventilators to roof curbs with zinc-plated hardware. Use concealed anchorages where possible. Refer to Section 07 72 00 "Roof Accessories."
- C. Install gravity ventilators with clearances for service and maintenance.
- D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07 92 00 "Joint Sealants" for sealants applied during installation.
- F. Label gravity ventilators according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."
- G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.
- H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.
- I. Refer to Section 07 720 0 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 DUCT CONNECTIONS

- A. Duct installation and connection requirements are specified in Section 23 31 13 "Ducts & Duct Accessories". Drawings indicate general arrangement of ducts and duct accessories.

END OF SECTION 23 37 23

SECTION 23 57 00 – HEAT EXCHANGERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Shell-and tube and gasketed-plate heat exchangers.

1.2 RELATED DIVISIONS AND SECTION

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- D. Section 23 05 93 - Testing, Adjusting, and Balancing
- E. Section 23 07 00 - HVAC Insulation
- F. Section 23 08 16 - Commissioning of HVAC System
- G. Section 23 20 00 - Building HVAC Services Piping
- H. Section 23 21 16 – Hydronic Piping Specialties
- I. Section 23 21 23 - Hydronic Pumps
- J. Section 23 22 16 – Steam and Condensate Heating Piping Specialties
- K. Section 23 25 00 – Water Treatment Systems
- L. Section 23 25 33 - HVAC Water Filtration Equipment
- M. Section 23 64 16 – Liquid Water Chillers
- N. Section 23 65 13 - Packaged Cooling Towers
- O. Section 23 82 39 - Unit Heaters
- P. Section 25 00 00 – Chiller Plant Control System
- Q. Section 25 00 10 – Hot Water Skid Control System

1.3 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, “Basic Mechanical Materials and

Methods.”

- B. Statement of piping and fitting material, and type of joint to be used for each piping system.
- C. Manufacturer's technical product data, installation instructions and description of accessories for each type to be used and system designation:
 - 1. Shell and Tube Heat Exchangers
 - 2. Plate and Frame Heat Exchangers

1.4 INFORMATIONAL SUBMITTALS

- A. Factory installation instructions.
- B. Mounting dimensioned details and equipment operating weights.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operating and maintenance manual with the following data:
 - 1. Product data submittal.
 - 2. Wiring diagrams.
 - 3. Operating instructions.
 - 4. Maintenance instructions.
 - 5. Alignment and adjustment procedures
 - 6. Troubleshooting guide.
 - 7. Exploded view diagrams.
 - 8. Parts lists.
- B. Product warranties for heat exchangers.
- C. Documentation of operating instructions.
- D. Documentation of commissioning demonstration.

1.6 PROJECT CONDITIONS

- A. Provide all materials and equipment specified in this section with performance requirements as stated herein or on the drawings.

1.7 WARRANTY

- A. Manufacturers standard warranty.

PART 2 PRODUCTS

2.1 SHELL-AND-TUBE HEAT EXCHANGERS

- A. Drawing Designation: 04 03 HW HXR-1 and 2.
- B. Manufacturers: Bell & Gossett; a Xylem Brand, Tranter, Alfa Laval, Accutherm
- C. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
- D. Capacities and Characteristics: As scheduled on drawings.
- E. Configuration: U-tube with removable bundle.
 - 1. Shell Materials: Steel.
 - 2. Head: Cast steel
 - 3. Tube:
 - a. Seamless copper tubes.
 - b. Tube diameter is determined by manufacturer based on service.
 - 4. Tubesheet Materials: Steel.
 - 5. Baffles: Steel.
- F. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tapings to shell before testing and labeling.
 - 1. 2 and Smaller: Threaded ends according to ASME B1.20.1.
 - 2. 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless- steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.
- G. Accessories
 - 1. Hangers and Supports:
 - a. Custom, steel supports and cradles for mounting on floor.
 - b. Factory-fabricated steel supports and cradles to ensure both horizontal and vertical support of heat exchanger.

2.2 PLATE HEAT EXCHANGERS

- A. Drawing Designation: 04 03 CH HXR-1.
- B. Manufacturers: Kelvion GEA (Basis of Design), Tranter, Alfa Laval, Accutherm
- C. Configuration: Freestanding assembly, consisting of frame support, top and bottom carrying

and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets. Floor-mounted heat exchangers must have integral legs with mounting feet.

- D. Capacities and Characteristics: As scheduled on drawings.
- E. Construction: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, "Pressure Vessels," Division 1.
- F. Heat Exchanger shall be AHRI 400 Certified.
- G. Heat exchanger shall be plate-type constructed to an operating pressure of 250 psig.
- H. Fixed head and follower head shall be mild steel plate fitted with stainless steel inserts for all connections so that all product contact parts are stainless. Top and bottom bars for carrying plates shall be stainless steel, shaped to receive top eye of plates and carry connector plate rollers. Frame and compression bolts shall have the capability for the future installation of 50 percent additional plates.
- I. Fixed head shall have two mild steel legs with flanged feet. End support shall be formed mild steel channel.
- J. Mild steel parts shall be painted.
- K. Connector plates shall be stainless steel solid boss type, suspended from rollers.
- L. Heat exchanger plates shall be one piece Type 304 stainless steel die stampings, mill bright or mechanically polished to a high luster F-210 finish.
- M. Gaskets shall be one-piece molded Nitrile rubber, treated for maximum life and adhesive qualities, cemented in place and readily replaceable in field.
- N. Piping Connections: Factory fabricated of materials compatible with heat-exchanger shell. Attach tappings to shell before testing and labeling.
 - 1. 2-inch and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2. 2-1/2-inch and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless-steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- O. Provide heat exchanger with stainless steel, aluminum, or painted carbon steel shroud provided by the heat exchanger manufacturer. Shroud shall cover the exposed top and sides of the plate pack.
- P. Heat Exchanger shall be provided with Inlet Strainers and Flange Cleanout Ports.
- Q. Free Cooling / Low Temp Application: Heat Exchanger shall include factory provided Insulation Kit w/ Drip Tray for units having fluid temperatures subject to external condensation.

2.3 QUALITY CONTROL

- A. Factory Tests: Test and inspect heat exchangers in accordance with ASME Boiler and Pres-

sure Vessel Code, Section VIII, "Pressure Vessels," Division 1. Affix ASME International label.

- B. Hydrostatically test heat exchangers to minimum of one and one-half times pressure rating before shipment.
- C. Heat exchangers will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 INSTALLATION OF HEAT EXCHANGER, GENERAL

- A. Equipment Mounting:
 - 1. Install floor-mounted heat exchangers on cast-in-place concrete equipment bases. Install all heat exchangers level and plumb in accordance with manufacturer's recommendations. Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."

3.2 INSTALLATION OF SHELL-AND-TUBE HEAT-EXCHANGER

- A. Heat Exchanger shall be part of a complete factory furnished steam to water skid package with individual equipment capacities as scheduled containing but not limited to the following:
 - 1. Pumps (04 03 HW PMP-1 and 2) as scheduled and pump appurtenances (end suction diffuser, isolation valves, check valves, flexible connectors, cyclone abrasive separator, and pressure gauges)
 - 2. Air separator (04 03 HW ASP-1) as scheduled and appurtenances (automatic air vents)
 - 3. Heat exchanger (04 03 HW HXR-1 and 2) as scheduled and appurtenances (relief valve, vacuum breaker, isolation valves)
 - 4. Expansion tank (04 03 HW EXT-1) as scheduled and appurtenances (pressure gauge, vent, isolation valves)
 - 5. Bypass water filter (04 03 HW FLT-1) as scheduled and appurtenances (pressure gauge, flow meter, balancing valve, shutoff valves)
 - 6. Terminal block I/O and power distribution cabinet and internal skid system control package.
 - 7. Pump VFD's
 - 8. Skid package interconnecting piping and wiring.
 - 9. Steam inlet/outlet connection flanges.
 - 10. Water inlet outlet connection flanges.

3.3 INSTALLATION OF GASKETED-PLATE HEAT EXCHANGER

- A. Install floor-mounted gasketed-plate heat exchangers on cast-in-place concrete equipment base, and fasten legs to base.
- B. Install metal shroud over installed gasketed-plate heat exchanger in accordance with manufac-

turer's written instructions.

3.4 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 23 20 00 "Building Services Piping" and Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for tube removal, service, and maintenance.
- C. Install piping adjacent to heat exchangers to allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of heat exchangers.
- D. Install shutoff valves at heat-exchanger inlet and outlet connections.
- E. Provide 3/4-inch hose end drain valves in all condenser and cooling tower water piping at point of connection to heat exchanger and on the equipment side of the isolation valves.
- F. Provide water bypass as sized in contract drawings for each circuit of the heat exchanger, complete with isolation valves.
- G. Install pressure-relief valves on heat-exchanger shells where a connection has been provided on shell. When no shell pressure-relief valve connection has been provided, install pressure-relief valve on shell outlet piping before any isolation valves.
- H. Install pressure-relief valves on heat-exchanger tube outlet piping before any isolation valves.
- I. Pipe pressure-relief valves, full size of valve connection, to floor drain.
- J. Install thermometer on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for thermometers specified in Section 23 20 00 "Building Services Piping."
- K. Install pressure gauges on each heat-exchanger fluid inlet and outlet piping. Comply with requirements for pressure gauges specified in Section 23 20 00 "Building Services Piping."

3.5 CLEANING

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. Isolate heat exchangers from piping before flushing piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blind flanges in flanged joints to isolate equipment.
- C. Flush heat-exchanger piping systems with clean water; then remove and clean or replace strainer screens before reopening flow to heat exchangers.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative:
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Heat exchanger will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers.

END OF SECTION 23 57 00

SECTION 23 64 16 - LIQUID WATER CHILLERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Building cooling refrigeration equipment and associated integral controls, supports, accessories and motors.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound, and Vibration Control
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 07 00 - HVAC Insulation
- G. Section 23 08 16 – Commissioning of HVAC Systems
- H. Section 23 20 00 - Building HVAC Services Piping
- I. Section 23 21 16 – Hydraulic Piping Specialties
- J. Section 23 21 23 - Hydronic Pumps
- K. Section 23 25 00 - Water Treatment Systems
- L. Section 23 25 33 – HVAC Water Filtration Equipment
- M. Section 23 65 13 - Packaged Cooling Towers
- N. Section 25 00 00 - Chiller Plant Control System
- O. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Equipment specified shall meet all requirements of International Energy Conservation Code (IECC), 2015 as amended by the DC Energy, Conservation Code, 2017, Section 6.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.

- C. AHRI rating and certification.
- D. Chillers shall meet the requirements of International Mechanical Code (IMC), 2015 as amended by the DC Mechanical Code, 2017.
- E. Comply with the following codes and standards: AHRI 550/590, AHRI 575, NEC, OSHA as adopted by the State, ETL, ASME Section VIII.
- F. The chiller shall be factory tested at the manufacturer's plant prior to shipment.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Sections 01 33 30 and 23 05 00.
- B. Manufacturer's technical product data, installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimension of components. Submittal shall include control cabinet layout and electrical wiring diagram:
 - 1. Liquid Water Chillers.
 - 2. Refrigerant Monitors.
- C. AHRI Certification and test reports.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.6 PROJECT CONDITIONS

- A. Provide all materials and equipment specified in this section with performance requirements as stated herein or on the drawings.

1.7 WARRANTY

- A. 1 Year Entire Unit Parts and Labor warranty. The chiller manufacturer's warranty shall cover parts and labor costs for the repair or replacement of defects in material or workmanship for a period of one year from equipment startup or 18 months from shipment, whichever occurs first. Refrigerant warranty for one year.
- B. Provide an additional four years of extended warranty on compressor parts and labor.

PART 2 PRODUCTS

2.1 LIQUID WATER CHILLERS

- A. Drawing Designation: 04 03 CH CHL-1, 2 and 3.
- B. Acceptable Manufacturers:
 - 1. Daikin Magnitude model WMC, including the standard product features and all special features required per the plans and specifications.
 - 2. Equal Products - Equipment manufactured by Multistack, Trane or York may be acceptable as an equal. Naming these products as equal does not imply that their standard construction or configuration is acceptable or meets the specifications. Equipment proposed "as equal", must meet the specifications including all architectural, mechanical, electrical, and structural details, all scheduled performance and the job design, plans and specifications.
- C. Unit Description:
 - 1. Provide and install as shown on the plans a factory assembled, charged, and tested water-cooled packaged centrifugal chiller. Each Chiller shall have no more than two oil-free, magnetic bearing, semi-hermetic centrifugal compressors (no exceptions). Each compressor shall have an integrated variable-frequency drive operating in concert with inlet guide vanes for optimized full and part load efficiency. On two-compressor units, the evaporator and condenser refrigerant sides and the expansion valve shall be common and the chiller shall be capable of running on one compressor with the other compressor or any of its auxiliaries inoperable or removed.
- D. Design Requirements:
 - 1. General: Provide a complete water-cooled, semihermetic oil-free centrifugal compressor water chiller as specified herein. The unit shall be provided according to standards indicated in Section 1.3. In general, unit shall consist of a minimum of two magnetic bearing, completely oil-free centrifugal compressors, refrigerant, condenser and evaporator, and control systems including integrated variable frequency drive, operating controls and equipment protection controls. Chillers shall be charged with refrigerant HFC-134a. If manufacturer offers a chiller using any HCFC refrigerant, manufacturer shall provide, in writing, documentation signed by an officer of the company assuring refrigerant availability and price schedule for a 20-year period.
 - 2. The entire chiller system, including all pressure vessels, shall remain above atmospheric pressure during all operating conditions and during shut down to ensure that non-condensables and moisture do not contaminate the refrigerant and chiller system. If any portion of the chiller system is below atmospheric pressure during either operation or shut down, the manufacturer shall include, at no charge:
 - a. A 20-year purge maintenance agreement that provides parts, labor, and all preventative maintenance required by the manufacturer's operating and maintenance instructions.
 - b. A complete purge system capable of removing non-condensables and moisture during operation and shut-down.
 - c. The manufacturer shall also include at no charge for a period of 20 years an annual oil and refrigerant analysis report to identify chiller contamination due to vacuum leaks. If the analysis identifies water, acid, or other contaminant levels higher than specified by the manufacturer, the oil and/or refrigerant must be replaced or returned to the manufacturer's original specification at no cost to the Government.
 - d. The manufacturer shall include a factory-installed and wired system that will enable service personnel to readily elevate the vessel pressure during shutdown to facilitate

leak testing.

E. Acoustics:

1. Sound pressure for the unit shall not exceed the following specified levels. Provide the necessary acoustic treatment to chiller as required. Sound data shall be measured in dB according to AHRI Standard 575 and shall include overall dBA. Data shall be the highest levels recorded at all load points.

2. Sound

Load	Overall	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
100%	83.5	46.0	55.5	65.5	70.5	74.5	76.0	80.0	74.5
75%	82.5	45.5	55.5	65.5	69.5	73.5	76.5	79.0	72.5
50%	81.0	45.0	54.5	64.0	69.0	71.0	74.5	77.5	70.0
25%	77.0	44.5	51.5	61.0	64.5	67.5	73.0	73.0	62.0

F. Chiller Components:

1. Compressors:

- a. The unit shall utilize a minimum of 2 magnetic bearing, oil-free, semihermetic centrifugal compressors. The compressor drive train shall be capable of coming to a controlled, safe stop in the event of a power failure.
- b. The motor shall be of the semi-hermetic type, of sufficient size to efficiently fulfill compressor horsepower requirements. It shall be liquid refrigerant cooled with internal thermal sensing devices in the stator windings. The motor shall be designed for variable frequency drive operation.
- c. If the compressor design requires a shaft seal to contain the refrigerant, the manufacturer shall supply a 20-year parts and labor warranty on the shaft seal and a lifetime refrigerant replacement warranty if a seal failure leads to refrigerant loss
- d. If the compressor/motor uses any form of antifriction bearing (roller, ball, etc.), the chiller manufacturer shall provide the following at no additional charge:
 - 1) A 20-year bearing warranty and all preventative maintenance as specified by the manufacturer's published maintenance instructions.
 - 2) At start up, a three-axis vibration analysis and written report to establish bearing condition baseline.
 - 3) An annual three-axis vibration analysis and written report indicating bearing condition.
- e. The chiller shall be equipped with a refrigerant cooled and integrated Variable Frequency Drive (VFD) to automatically regulate compressor speed in response to cooling load and the compressor pressure lift requirement. If a condenser water-cooled VFD is supplied, the manufacturer shall supply factory installed dual water filters with a bypass valve and pressure differential switch factory wired to the chiller control panel to indicate that a filter has clogged and requires service. The pressure differential switch shall also provide a separate dry contact which can be connected to the BAS system as a means of notifying operating personnel of the need to service the filters. If the condenser cooling circuit includes an intermediate heat exchanger, it must be of the brush cleanable shell and tube style. Braze plate heat exchangers which cannot

be field cleaned are not acceptable. Movable inlet guide vanes and variable compressor speed, shall provide unloading. The chiller controls shall coordinate compressor speed and guide vane position to optimize chiller efficiency.

- f. Each compressor circuit shall be equipped with a 5 percent -line reactor to help protect against incoming power surges and help reduce harmonic distortion.

2. Evaporator and Condenser:

- a. The evaporator and condenser shall be separate vessels of the shell-and-tube type, designed, constructed, tested and stamped according to the requirements of the ASME Code, Section VIII. Regardless of the operating pressure, the refrigerant side of each vessel will bear the ASME stamp indicating compliance with the code and indicating a test pressure of 1.1 times the working pressure, but not less than 100 psig. The tubes shall be individually replaceable and secured to the intermediate supports without rolling or expanding to facilitate replacement if required.
- b. The evaporator shall be flooded type with copper tubes rolled into carbon steel tubesheets. The evaporator shall have right-hand connections when looking at the unit control panel. The evaporator shall have dished heads with valved drain and vent connections. Water connections shall be grooved suitable for Victaulic couplings. The heads shall be carbon steel and the tubesheets shall be carbon steel. The waterside shall be designed for a minimum of 150psig. The wall copper tubes shall be 0.025 in.
- c. The condenser shall have tubes rolled into carbon steel. The condenser shall have right-hand connections when looking at the unit control panel. The condenser shall have dished heads with valved drain and vent connections. The waterside shall be designed for a minimum of 150psig. Water connections shall be grooved suitable for Victaulic couplings. The heads shall be carbon steel and the tubesheets shall be carbon steel. The wall copper tubes shall be 0.025 in.
- d. An electronic expansion valve shall control refrigerant flow to the evaporator. Fixed orifice devices or float controls with hot gas bypass are not acceptable because of inefficient control at low load conditions. The liquid line shall have moisture indicating sight glass.
- e. Provide sufficient isolation valves and condenser volume to hold the full unit refrigerant charge in the condenser during servicing or provide a separate pumpout system and storage tank sufficient to hold the charge of the largest unit being furnished.
- f. Re-seating type spring loaded pressure relief valves according to ASHRAE-15 safety code shall be furnished. The evaporator shall be provided with single or multiple valves. The condenser shall be provided with dual relief valves equipped with a transfer valve so one relief valve can be removed for testing or replacement without loss of refrigerant or removal of refrigerant from the condenser. Rupture disks are not acceptable. If rupture disks are required on negative pressure units to prevent air and moisture ingress, then factory mounted spring-loaded pressure relief valves shall be provided in series with the rupture disks to contain the remaining refrigerant in the event of vessel over-pressurization. The space between the rupture disk and the relief valve shall include a suitable telltale indicator integrated into the chiller control system to alert the operator that a potential safety issue exists in the pressure relief system.
- g. The evaporator vessel, including water heads, suction line, and any other component or part of a component subject to condensing moisture shall be insulated with 3/4-inch thick CFC and HCFC-free closed-cell flexible elastomeric foam insulation material with 100 percent adhesive coverage. The insulation shall have an additional outer protective layer of 3mm thick PE embossed film to provide superior damage resistance. Insulation without the protective outer film shall not be acceptable. UV resistance level shall meet or exceed a rating of 'Good' in accordance with the UNI ISO 4892 - 2/94 testing method. All joints and seams shall be carefully sealed to form a

- vapor barrier.
 - h. Provide factory-mounted and wired, thermal-dispersion water flow switches on each vessel to prevent unit operation with no or low water flow. Paddle and pressure differential type switches are not acceptable due to high rates of failure and false indications from these types of flow indicators.
- 3. Vibration Isolation:
 - a. Provide neoprene waffle-type vibration isolators for each corner of the unit.
- 4. Power Connections:
 - a. The power connection shall be: Single Point with non-metal compressor conduits and Disconnect Switch with a minimum 35k SCCR rating
- 5. Chiller Control
 - a. The unit shall have a microprocessor-based control system consisting of a 15-inch VGA touch-screen operator interface and a unit controller.
 - b. The touch-screen shall display the unit operating parameters, accept setpoint changes (multi-level password protected) and be capable of resetting faults and alarms. The following parameters shall be displayed on the home screen and also as trend curves on the trend screen:
 - 1) Entering and leaving chilled water temperatures
 - 2) Entering and leaving condenser water temperatures
 - 3) Evaporator saturated refrigerant pressure
 - 4) Condenser saturated refrigerant pressure
 - 5) Percent of 100 percent speed (per compressor)
 - 6) Percent of rated load amps for entire unit
 - c. In addition to the trended items above, all other important real-time operating parameters shall also be shown on the touch-screen. These items shall be displayed on a chiller graphic showing each component. At a minimum, the following critical areas must be monitored:
 - 1) Compressor actual speed, maximum speed, percent speed
 - 2) Liquid line temperature
 - 3) Chilled water setpoint
 - 4) Compressor and unit state and input and output digital and analog values
 - d. A fault history shall be displayed using an easy to decipher, color coded set of messages that are date and time stamped. Time interval scale shall be user selectable as 20 mins, 2 hours, or 8 hours. The alarm history shall be downloadable from the unit's USB port. An operating and maintenance manual specific for the unit shall be viewable on the screen.
 - e. All setpoints shall be viewable and changeable (multi-level password protected) on the touch screen and include setpoint description and range of set values.
 - f. Automatic corrective action to reduce unnecessary cycling shall be accomplished through preemptive control of low evaporator or high discharge pressure conditions to keep the unit operating through abnormal transient conditions.
 - g. The chiller shall be capable of sequencing up to four other similar chillers for WMC

- models. The contractor shall furnish and wire network isolators for n-1 units.
- h. The chiller shall be capable of automatic control of: evaporator and condenser pumps (primary and standby), up to 3 stages of cooling tower fan cycling control and a tower modulating bypass valve or cooling tower fan variable frequency drive.
 - i. The factory mounted controller(s) shall support operation on a network via BACnet® w/RS485 and Ethernet
 - j. as specified by the successful Building Automation System (BAS) supplier.
 - k. The information communicated between the BAS and the factory mounted unit controllers shall include the reading and writing of data to allow unit monitoring, control and alarm notification as specified in the unit sequence of operation and the unit points list. Chiller manufacturer shall provide a complete points list to the controls contractor.
 - l. All communication from the chiller unit controller as specified in the points list shall be via standard BACnet objects. Proprietary BACnet objects shall not be allowed. BACnet communications shall conform to the BACnet protocol (ANSI/ASHRAE135-2020). A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided along with the unit submittal.

G. Additional Items:

- 1. The following additional items shall be furnished:
 - a. To ensure quick and trouble free start up and commissioning, each chiller shall pass a full battery of factory tests. These tests shall include the verification of operating and compressor controls to ensure full unit functionality and manufacturing integrity. Any deviation from stringent factory quality standards shall be remedied prior to shipment.
 - b. Certifications: ETL/CETL Approval. Certified to AHRI 550/590. Meets ASHRAE 90.1 2019 Standard
 - c. Factory installed thermal dispersion flow switches for the evaporator and condenser.
 - d. Factory 3/4-inch insulation on the evaporator shell, connection heads, suction piping, and compressor inlet
 - e. Provide a BacNet MSTP communication board

2.2 REFRIGERANT LEAK MONITOR

- A. Refrigerant Gas Monitoring Systems shall be per requirements of Specification 25 00 00 70, "Instrumentation".

PART 3 EXECUTION

3.1 LIQUID WATER CHILLERS

- A. Install in accordance with manufacturers recommendations.
- B. Manufacturer's Supervision: Furnish services of manufacturer's trained representative to supervise:
 - 1. Testing machine(s) under pressure for leaks.
 - 2. Evacuation and dehydration of machine using manufacturer's high vacuum pump.
 - 3. Charging machine(s) with refrigerant for centrifugal units.

4. Starting machine(s).
 5. If centrifugal machines are leak tested in factory and shipped to the job site under vacuum, steps 1 and 2 above do not apply, provided vacuum has not been broken. If vacuum has been broken, Steps 1 and 2 must be completed before charging and starting machine. Machines must be tested with pressure gage to determine whether or not vacuum has been broken.
- C. Instruction: Furnish services of manufacturer's trained representative to instruct Government's designee for a total of five 8-hour days for centrifugal machines of which at least one day will occur after 30 days' operation by the designee. At conclusion of instruction, manufacturer shall advise Government, in writing, whether designee is qualified to have charge of the installation. Video record instruction sessions. Provide one copy of video recording with the O&M Manuals.
- D. Tests: Test refrigeration equipment under direction of the Engineer to demonstrate specification compliance. Furnish all labor and instruments. Performance shall be within limits of latest ARI Standard for Testing Centrifugal Water Chillers.
- E. Pipe discharge from pressure relief valves and rupture disc to exterior of the building. Pipe purge unit discharge to relief valve discharge. Provide flexible connection and piping to chillers in accordance with chiller manufacturer's recommendations and instructions. The discharge termination shall be located so as to avoid all safety hazards and shall be to atmosphere not less than 15 feet above ground and not less than 20 feet from windows, doors, and air intake openings.
- F. Provide water piping for oil cooler, purge condenser, motor cooler, etc., including solenoid valve, shutoff valves, strainers in accordance with manufacturer's recommendations.
- G. Provide 3/4-inch valved drain with hose connection and manual air vent for each water box.
- H. Flow switches for condenser and chilled water flow shall be installed in piping as indicated.
- I. Adjust chiller alignment on concrete foundations, sole plates, or su-bases as called for on the drawings.
- J. Arrange the piping on each vessel to allow for dismantling the pipe to permit head removal and tube cleaning.
- K. Coordinate electrical installation with electrical contractor.
- L. Coordinate controls with automatic controls contractor.
- M. Provide all material required to ensure a fully operational and functional chiller.
- N. Provide metal signs with minimum 0.5-inch letter designating main shutoff valves to each vessel, main electrical control, remote control switch and pressure limiting devices.
- O. Provide a sign outside the door to the refrigerant room giving direction for operation of the system and the following:
1. Instruction for shutting down the system in case of emergency.
 2. The name, address, and day and night telephone numbers for obtaining service.
 3. The name, address, and telephone number of the municipal inspection department having jurisdiction, and instructions to notify said department immediately in case of emergency.

3.2 REFRIGERANT LEAK MONITOR

- A. Mount sensor near the floor as recommended by manufacturer. Mount top of monitor 60 inches above the floor.
- B. Provide tubing connection from monitor to sensor.
- C. Provide 120-volt connection to nearest emergency electric panel.
- D. Provide connection to remote alarm, building automation system and ventilation system operation.
- E. Where a source of purge air is required for unit calibration, connect purge air tubing (to the intake plenum of the adjacent air handling units).

END OF SECTION 23 64 16

SECTION 23 65 13 - PACKAGED COOLING TOWERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Factory assembled cooling towers used to reject heat from the refrigeration and liquid water chiller process. The cooling towers shall be complete with specified and indicated components and additional features required for the intended application.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting and Balancing
- F. Section 23 08 16 - Commissioning of HVAC System
- G. Section 23 20 00 - Building HVAC Services Piping
- H. Section 23 21 16 – Hydraulic Piping Specialties
- I. Section 23 21 23 - Hydronic Pumps
- J. Section 23 25 00 - Water Treatment Systems
- K. Section 23 64 16 - Liquid Water Chillers
- L. Section 25 00 00 – Chiller Plant Control System
- M. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Equipment specified shall meet all requirements of ASHRAE Standard 90.1 Section 6.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- D. ASME Compliance: Fabricate and label heat-exchanger coils to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- E. Cooling tower thermal performance shall be certified by the Cooling Technology Institute (CTI) certification of Standard 201. Lacking such certification, a field thermal performance test shall be performed in accordance with CTI Acceptance Code ATC-105 by CTI or a CTI approved testing company. The Contractor shall include in the bid price, all cost for instrumentation as well as preparation and conducting the CTI field performance test. Should the field performance test prove the tower performance is deficient, the tower manufacturer shall have the necessary alterations performed to correct the performance deficiency. A second performance test shall be performed after the tower alterations and if the performance is deficient, the tower shall be replaced by a CTI certified tower. Tower performance tests, alterations or tower replacement shall be at no additional cost to the Government. The tower warranty period shall not start until the field performance test is acceptable.
- F. Upon completion of tower installation, the manufacturer's representative shall inspect tower, including optional features to assure proper operation of all components for design conditions.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and 23 05 00, "Basic Mechanical Materials and Methods".
- B. Manufacturer's technical product data, installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimension of components.
- C. Electrical power connection control panel layout and electrical wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. CTI Certification: For certification required in "Quality Assurance" Article.
- B. Warranty coverage statement.

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed in this section form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Provide all materials and equipment specified in this section with performance requirements as stated herein and on the drawings.
- B. Type, capacity, fan horsepower, special construction features and other requirements are scheduled on the drawings.
- C. Maximum Drift Loss: 0.2 percent of water circulated.

- D. By submitting the cooling tower(s) for inclusion in the work, the Contractor acknowledges that he is familiar with the details and restraints, if any, of the proposed installation, and that the cooling tower(s) submitted for inclusion in the work will meet or exceed the indicated requirements when installed in accordance with the Contract Documents.

1.8 WARRANTY

- A. A full warranty shall be provided on the entire cooling tower of stainless-steel construction, including mechanical components, for a period of 5 years after operational acceptance of the cooling tower. Operational acceptance shall include field performance test if tower is not CTI certified as stated under "Quality Assurance." Drive belts shall be included in this warranty.

PART 2 PRODUCTS

2.1 INDUCED DRAFT, PROPELLER FAN COOLING TOWERS

- A. Drawing Designation: 04 10 CW CTR-1, 2 and 3.
- B. Induced draft, dual air inlet, crossflow design equal to Baltimore Aircoil, Series 3000:
1. The cooling tower shall be constructed with a sturdy structural frame designed to transmit all wind and mechanical loads to the equipment anchorage. The frame shall be constructed of heavy-gauge steel angles and channels.
 2. All steel panels and structural members, including the structural frame, hot and cold-water basins, distribution covers, fan deck and fan cylinder shall be constructed of Type 304 stainless steel and assembled with Type 304 stainless steel nut and bolt fasteners. All factory seams in the cold-water basin shall be welded to ensure watertight assembly and welded seams shall be warranted against leaks for five (5) years. Stainless steel basins with bolted seams are not acceptable. The entire cooling tower, including fan motor, drive system, bearings, and structure, shall be backed by a comprehensive Louver-to-Louver Five-Year warranty. Type 301 Stainless Steel shall not be an acceptable alternative. In addition, the materials of construction must be suitable for operation with a circulating water pH of 6.5 - 9.0 without periodic passivation.
 3. Debris Screens: Provide debris screens over the cold-water basin below the air inlets. Screens shall be constructed of 1 by 1-inch hot dipped galvanized wire mesh to prevent debris from entering tower.
- C. Additional Cooling Tower Features:
1. Collection Basin: The cold-water basin shall be constructed of heavy-gauge Type 304 stainless steel panels and structural members. All factory seams shall be welded to ensure watertight construction and welded seams shall be warranted against leaks for a period of five (5) years from date of shipment. Type 301 or Series 300 Stainless steel basins with bolted seams are not acceptable. Basin shall include a depressed section with drain/clean-out connection. The basin area under the fill shall be sloped toward the depressed section to facilitate cleaning.
 2. Removable Stainless-Steel strainer with openings smaller than nozzle orifices.
 3. Overflow and drain connections.
 4. Makeup water connection.

5. Outlet Connection: Beveled for welding and grooved for mechanical coupling.
6. Removable equalization flume plate between adjacent cells of multiple-cell towers.
7. Equalizer connection for field-installed equalizer piping.
8. Basin Sweeper Distribution Piping and Nozzles:
 - a. Pipe Material: PVC.
 - b. Nozzle Material: Plastic.
 - c. Configure piping and nozzles to minimize sediment from collecting in the collection basin.
9. Electric Basin Heater:
 - a. Copper Electric Immersion Heaters: Installed in a threaded coupling on the side of the collection basin.
 - b. Heater Control Panel: Mounted on the side of each cooling tower cell.
 - c. Enclosure: NEMA 250, Type 3R
 - d. Magnetic contactors controlled by a temperature sensor/controller to maintain collection basin water-temperature set point. Water-level probe shall monitor cooling tower water level and de-energize the heater when the water reaches low-level set point.
 - e. Control-circuit transformer with primary and secondary side fuses.
 - f. Terminal blocks with numbered and color-coded wiring to match wiring diagram.
 - g. Single-point, field-power connection to a nonfused disconnect switch and heater branch circuiting complying with NFPA 70
 - h. Basin heater controls (setpoint) controlled by PLC basin temperature transmitter. Status monitoring by PLC.
10. Collection Basin Water-Level Controller with Motorized Valve:
 - a. Provide Continuous Level Transmitters (CLT) for each tower basin for level control.
 - b. CLT requirements shall be per Specification 25 00 00 70, "Instrumentation."
 - c. Motorized Valve: Controlled and powered through level controller in response to water-level set point.
11. Gravity Water Distribution Basin: Nonpressurized design with head of water level in basin adequate to overcome spray nozzle losses and designed to evenly distribute water over fill throughout the flow range indicated:
 - a. Material: Construction similar to the cold-water basin.
 - b. Location: Over each bank of fill with easily replaceable plastic spray nozzles mounted in bottom of basin.
 - c. Inlet Connection: Beveled for welding and grooved for mechanical coupling.
 - d. Joints and Seams: Sealed watertight.
 - e. Partitioning Dams: Same material as basin to distribute water over the fill to minimize icing while operating throughout the flow range indicated.
 - f. Removable Panels: Same material as basin to completely cover top of basin. Secure panels to basin with removable stainless-steel hardware.
 - g. Valves: Contractor to provide and install a valve at each inlet connection and arranged to balance or shut off flow to each gravity distribution basin.
 - h. Single-Inlet, Field Pipe Connection: PVC pipe arranged to provide balancing of flow within cooling tower cell without the need for additional balancing valves.

12. Air Inlet Screens: Provide screens over air inlet louvers or as part of inlet louvers to prevent debris from entering tower.
13. Combined Inlet Shields:
 - a. Material: PVC.
 - b. UV Treatment: Inhibitors to protect against damage caused by UV radiation.
 - c. Installed on the air inlet face to minimize air resistance, prevent water splash out, and minimize sunlight exposure to reduce the potential for algae growth in the cold-water basin.
14. Fill & Drift Eliminators:
 - a. Materials: PVC, with maximum flame-spread index of 5 according to ASTM E 84.
 - b. Minimum Thickness: 13 mils, before forming.
 - c. Fabrication: Fill-type sheets, fabricated, formed, and bonded together after forming into removable assemblies that are factory installed by manufacturer.
 - d. Fill Material Operating Temperature: Suitable for entering-water temperatures up through 120 degrees F
15. Axial Fan: Balanced at the factory after assembly:
 - a. Blade Material: Aluminum
 - b. Hub Material: Aluminum
 - c. Blade Pitch: Field adjustable.
 - d. Protective Enclosure: Removable, galvanized-steel, wire-mesh screens complying with OSHA regulations.
 - e. Fan Shaft Bearings: Fan(s) and shaft(s) shall be supported by heavy-duty, self-aligning, grease packed ball bearings with moisture proof seals and integral slinger collars, designed for a minimum L10 life of 150,000 hours (500,000 Hr. Avg. Life).
 - f. Bearings Grease Fittings: Extended lubrication lines to an easily accessible location.
16. Belt Drive:
 - a. Service Factor: 1.5 based on motor nameplate horsepower.
 - b. Sheaves: Fan and motor shafts shall have taper-lock sheaves fabricated from corrosion-resistant materials.
 - c. Belt: One-piece, multigrooved, solid-back belt.
 - d. Belt Material: Oil resistant, nonstatic conducting, and constructed of neoprene polyester cord.
 - e. Belt-Drive Guard: Comply with OSHA regulations
17. Motor: Variable speed (1800 rpm) premium efficiency, cooling tower duty motor mounted on adjustable steel base. Fan motors will be inverter duty type designed per NEMA Standard MG1, Section IV Part 31., Motors will include a separate external variable frequency drive (Remote VFD to be furnished by the controls contractor located indoors in the mechanical room) and an internal space heater that can be wired to remove condensation when motor is not in use.
18. Motor Removal Davit: The unit will be equipped with a mechanical equipment removal davit. The motor will lower from the mechanical equipment supports down to grade. Davit will attach to the unit without the need for tools. If tools are required for davit installation or removal, provide (1) davit for each motor provided.
19. Control Package: to ship loose for field mounting and wiring:

- a. Enclosure: NEMA 250, Type 3R; with panel space heater and ventilation fan for outdoor installation
 - b. Integral Disconnect: Motor Circuit Protector (MCP) The MCP shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508F rating (up to 100A frame size) with a minimum interrupting rating of 30,000 AIC
 - c. Control-circuit transformer with primary and secondary side fuses
 - d. Terminal blocks with numbered and color-coded wiring to match wiring diagram. Spare wiring terminal block for connection to external controls or equipment
 - e. NEMA-rated variable frequency motor controller Drive/Off/Bypass selector switch, hand-off-auto switch, and overcurrent protection for each motor. Provide variable frequency controller with 3-contactor manual bypass and 5 percent input line reactor(s) for each variable-speed motor indicated. Variable frequency drive requirements shall be per Specifications 25 00 00 20, "Variable Frequency Controller" and Specification 25 00 00 30, "Variable Frequency Drive Systems". Variable frequency drive furnished by the controls contractor.
 - f. The control panel shall include all necessary terminal inputs to control the sequence of operations from a Building Management System including at a minimum: VFD start/stop command, VFD reference speed
 - g. Terminal inputs shall be provided for Vibration Cut Out Switch.
 - h. Visual indication of status lights and alarm contact for each motor
 - i. External mount N3R VFD operator/keypad selection, LCD multi-line display
 - j. Cooling Tower Duty motor space heater power terminals and relay provided to power and sequence 120V motor space heater; field wired
 - k. All internal power and control wiring to be installed and tested in the factory
 - l. A Five Year Parts Warranty shall be provided as a standard option by VFD manufacturer.
20. Vibration Switch: For each fan drive.
- a. Enclosure: NEMA 250, Type 4
 - b. Vibration Detection: The mechanical vibration cut out switch will be guaranteed to trip at a point so as not to cause damage to the cooling tower. To ensure this, the trip point will be a frequency range of 0 to 3,600 RPM and a trip point of 0.2 to 2.0 g's.
 - c. Provide switch with manual-reset button for hardwired connection to fan motor electrical circuit.
21. Personnel Access Components:
- a. Doors: Large enough for personnel to access cooling tower internal components from both cooling tower end walls. Doors shall be operable from both sides of the door.
 - b. External Ladders with Safety Cages: Aluminum fixed ladders with ladder extensions to access external platforms and top of cooling tower from adjacent grade without the need for portable ladders. Comply with 29 CFR 1910.27.
 - c. Louver Face Platforms with Handrails: galvanized-steel bar grating at cooling tower access doors when cooling towers are elevated and not accessible from grade.
 - d. Access Door Platform: A galvanized steel platform and aluminum ladder to grade shall be provided at an access door to access the plenum section of the cooling tower. All working surfaces shall be able to withstand 60 psf live load.
 - e. Internal Walkway: An internal walkway shall be provided in the plenum section to provide for inspection and maintenance. All working surfaces shall be able to withstand 50 psf live load or 200-pound concentrated load. Other components of the cooling tower, i.e., basin and fill/drift eliminators, shall not be considered an internal working

surface. Cooling tower manufacturers that promote these surfaces to be used as a working platform shall provide a two-year extended warranty to the Government to repair any damage to these surfaces caused during routine maintenance.

22. Equalizer or bypass connections shall be provided as shown on the drawing.

D. Manufacturers: BAC, Evapco, Marley or an approved equal.

PART 3 EXECUTION

3.1 PACKAGED COOLING TOWERS

- A. Support Steel: Provide steel grilleage as required by tower manufacturer. Bolt grilleage to tower. Apply Glidden Steel Protection System 32-CTE Coat Tar Epoxy System in shop unless field welding is necessary. If field welding is necessary, follow shop sandblast with shop coat of PA-10 Etching Primer with the two epoxy coats applied in field after welding.
- B. Bolt grilleage to isolators or to under supports.
- C. Upon completion of installation, obtain services of manufacturer to inspect tower, including optional features to assure proper operation of all components for design conditions.
- D. Lubricate bearings prior to fan operation.
- E. Deliver spare belts to Government.
- F. Coordinate wiring to motor, basin heaters, makeup water motorized valve, and vibration cutout switch. See Division 26, "Electrical."
- G. Install water level control in makeup water line at tower. Install with isolation valves on each side of motorized valve and with full side bypass manual valve and piping around the motorized valve. Bypass valve shall be normally closed and have tag to identify as normally closed.
- H. Provide backflow preventer on makeup water line to motorized valve on water level control.
- I. Level multiple towers connected to a common system to have identical basin elevations. Provide equalizer line between basins.
- J. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- K. Install piping adjacent to cooling towers to allow service and maintenance.
- L. Install flexible pipe connectors at pipe connections of cooling towers mounted on vibration isolators.
- M. Provide drain piping with valve at cooling tower drain connections and at low points in piping.
- N. Connect cooling tower overflows and drains, and piping drains to sanitary sewage system.

- O. Domestic Water Piping: Comply with applicable requirements in Section 22 20 00 "Building Plumbing Services Piping." Connect to water-level control with shutoff valve and union, flange, or mechanical coupling at each connection.
- P. Supply and Return Piping: Comply with applicable requirements in Section 23 20 00 "Building HVAC Services Piping" and Section 23 21 16 Hydronic Piping Specialties." Connect to entering cooling tower connections with shutoff valve, balancing valve, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve. Connect to leaving cooling tower connection with shutoff valve. Make connections to cooling tower with a union, flange, or mechanical coupling.
- Q. Equalizer Piping: Piping requirements to match supply and return piping. Connect an equalizer pipe, full size of cooling tower connection, between tower cells. Connect to cooling tower with shutoff valve.
- R. Engage a factory-authorized service representative to perform startup service.
- S. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- T. Obtain performance data from manufacturer.
- U. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
- V. Clean entire unit including basins.
- W. Verify that accessories are properly installed.
- X. Verify clearances for airflow and for cooling tower servicing.
- Y. Check for vibration isolation and structural support.
- Z. Verify fan rotation for correct direction and for vibration or binding and correct problems.
- AA. Adjust belts to proper alignment and tension.
- BB. Operate variable-speed fans through entire operating range and check for harmonic vibration imbalance. Set motor controller to skip speeds resulting in abnormal vibration.
- CC. Check vibration switch setting. Verify operation.
- DD. Verify water level in tower basin. Fill to proper startup level. Check makeup water-level control and valve.
- EE. Verify operation of basin heater and control.
- FF. Verify that cooling tower air discharge is not recirculating air into tower or HVAC air intakes. Recommend corrective action.
- GG. Replace defective and malfunctioning units.

- HH. Start cooling tower and associated water pumps. Follow manufacturer's written starting procedures.
- II. Prepare a written startup report that records the results of tests and inspections.
- JJ. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain cooling towers.

END OF SECTION 23 65 13

SECTION 23 73 13 13 - INDOOR BASIC AIR HANDLING UNITS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Indoor air handling equipment and associated integral supports, accessories, motors and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 08 16 - Commissioning of HVAC Systems
- G. Section 23 20 00 - Building HVAC Services Piping
- H. Section 23 21 16 - Hydronic Piping Specialties
- I. Section 23 31 13 – Ducts and Duct Accessories
- J. Section 23 34 16 – Fans
- K. Section 23 37 13 – Air Outlets and Inlets
- L. Section 25 00 00 – Chiller Plant Control System
- M. Section 25 00 10 – Hot Water Skid Control System
- N. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air handling units and components.
- C. AHRI Certification: Air handling units and their components shall be factory tested according to

AHRI 430, "Performance Rating of Central Station Air Handling Unit Supply Fans," and shall be listed and labeled by AHRI.

- D. AMCA Compliance: Fan performance shall be factory tested to AMCA 210.
- E. AMCA Certification: Air handling unit fan sound ratings shall comply with AMCA 300, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data" and AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data."
- F. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

1.4 COORDINATION

- A. Installing contractor will coordinate the following items with applicable trades:
 - 1. Structural supports for units.
 - 2. Size and location of concrete bases/housekeeping pads.
 - 3. Location of roof curbs, unit supports and roof penetrations.
 - 4. Ductwork sizes and connection locations.
 - 5. Piping size and connection/header locations.
 - 6. Interference with existing or planned ductwork, piping and wiring.
 - 7. Electrical power requirements and wire/conduit and over current protection sizes.
 - 8. Trap height requirements.

1.5 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of component. For each air handling unit indicate:
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan performance curves with system operating conditions indicated.
 - b. Certified fan sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil performance ratings with system operating conditions indicated.
 - 5. Filters with performance characteristics.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Include in emergency, operation, and maintenance manuals for

air handling units.

1.7 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.8 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.

1.9 WARRANTY

- A. Warranty unit and factory mounted end devices for eighteen (18) months from date of shipment. Warranty will be limited to manufacturer's defects on parts. Warranty does not include parts associated with routine maintenance, such as belts, air filters, etc. Warranty work shall be performed by manufacturer's factory-trained and factory-employed technician. Warranty does not extend to alterations, modifications, or external components installed after unit is shipped.

1.10 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents:
 - 1. Filters: One set for each air handling unit.
 - 2. Gaskets: One set for each access door.
 - 3. Fan Belts (where required): One set for each air handling unit fan.

PART 2 PRODUCTS

2.1 GENERAL DESCRIPTION

- A. Drawing Designation: 04 02 SA AHU-1, 04 03 SA AHU-1
- B. Air-handling units are designed and built to meet performance detailed in this submittal.
- C. Unit will be complete with fans, motors, coils, dampers, controls, access doors and other components/options, as shown on product drawings, wiring diagrams, and as described in performance specifications.

- D. Fans and drives will be balanced to limit vibration at operating speeds.
- E. Unit will ship in one (1) piece whenever possible. Shipping splits will be provided when necessary. Lifting lugs will be provided where required for proper lifting.
- F. Unit casing will be factory insulated.
- G. Units will be ETL labeled.

2.2 BASE RAIL

- A. Structural base rail will be provided under the full perimeter of the unit, formed from mill galvanized steel.

2.3 UNIT CASING

- A. Unit is specifically designed for indoor applications.
- B. Unit casing will consist of a structural frame and insulated roof, wall, and floor panels.
- C. Removal of wall panels will not affect structural integrity of units.
- D. Unit casing will be insulated with spray injected foam to achieve a minimum thermal resistance of R13 hr-ft²-°F/BTU. Insulation application will meet the requirements of NFPA 90A
- E. Insulation system will be resistant to mold growth in accordance with a standardized test method such as UL 181 or ASTM C 1338
- F. Unit will conform to ASHRAE Standard 111 Class 6 for casing leakage no more than 1% of design airflow at 1.25 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections.
- G. Wall panels and access doors will deflect no more than L/240 when subjected to 1.5 times design static pressure up to a maximum of +8 inches w.g. in positive pressure sections and -8 inches w.g. in negative pressure sections. 'L' is the panel-span length and 'L/240' is the deflection at panel midpoint.
- H. Unit will have double wall, 2" insulated panels for walls, roof, and floor. Exterior skin will be galvanized sheet steel. Individual segments will have galvanized sheet steel or stainless sheet steel (CC section) interior liner.
- I. Floor panels will be double wall construction, designed to provide at most L/240 deflection when subjected to a 300 lb. load at mid-span.
- J. Double wall access doors will be provided on sections as shown on product drawings.
 - 1. Stainless steel hinges permit a 180° door swing.
 - 2. Access door will be of the same material type as exterior/interior casing.
 - 3. Access door latches will use a roller cam latching mechanism.

- K. View ports will be double-pane tempered glass.

2.4 DRAIN PANS

- A. Primary and auxiliary drain pans will be double wall with an insulation R-value of 6.25 hr-ft²-°F/(BTU-in).
 - 1. Drain pans comply with the guidelines of ASHRAE 62.
 - 2. Drain pans will be double sloped at least 1/8" per foot, and have no horizontal surfaces.
 - 3. Drain connection material will be the same as drain pan.
 - 4. Drain pans drain to one point.
 - 5. Drain connections will be welded to drain pans
 - 6. Drain pans will have at least 1" clearance between pan and coil supports.

2.5 FANS

- A. Fans will provide CFM and static pressure, as shown in performance specifications.
- B. Fans will be Class I, II, or III, as required to meet selected RPM and horsepower shown in performance specifications.
- C. Fans will be direct drive SWSI (plenum), as shown on product drawings.
- D. Fans will have airfoil blades, as shown in performance specifications.
- E. Airfoil fans will bear the AMCA Seal. Airfoil fan performance will be based on tests in accordance with AMCA standard 210 and will comply with the requirements of AMCA certified ratings programs for air and sound. Airfoil wheels will comply with AMCA standards 99 2408 69 and 99 2401 82.
- F. Fan and motor assembly will be internally mounted on a common base. Fan and motor base will be spring isolated on a full width isolator support channel.
 - 1. Fan motor will be on an adjustable base.
 - 2. Fan discharge will be connected to cabinet via a flexible connection.
 - 3. Access doors will be provided as shown on product drawing.

2.6 ELECTRICAL MOTORS

- A. Motor shall be true synchronous speed, permanent magnet technology, IE4+ efficient, totally enclosed fan cooled (TEFC) rated for severe duty or higher.
- B. Motor shall be of HP as listed on schedule and be selected for a minimum of 15-20% over calculated BHP. The motor service factor shall be a minimum of 1.0 and an efficiency IE3 when operating on a VFD. Motor shall be of HP listed on schedule; selected to provide adequate torque throughout entire range of fan operation and not exceed nameplate HP when fan operates at synchronous motor speed.
- C. Motor shall be designed for continuous duty operation, NEMA Design B with class H insulation.

- D. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.
 - E. Motors shall be "Inverter Duty Rated" per NEMA Std. MG1 part 31.4.4.2 and labeled as such.
 - F. Variable frequency PWM driven motors shall include a circumferential, conductive microfiber shaft grounding ring or equivalent shall be installed on the AC motor to discharge shaft currents to ground.
 - G. Provide stainless steel nameplate indicating the following:
 - 1. NEMA efficiency index nominal efficient (MB1-12.53BO).
 - 2. AFBMA bearing numbers.
 - 3. Lubrication instructions.
 - H. Acceptable motor manufactures:
 - 1. Marathon Three Phase SyMax Permanent Magnet Motors
 - 2. Baldor EC Titanium
- 2.7 FAN VARIABLE FREQUENCY DRIVES – PROVIDED BY OWNER, WIRED IN THE FIELD BY ELECTRICAL CONTRACTOR.
- 2.8 MANUFACTURED HEATING AND COOLING COILS
- A. Manufactured coils described in this specification will include:
 - 1. Water coil capacity and pressure drop performance will be certified in accordance with AHRI Standard 410, when selected within fluid velocity, inlet fluid temperature, and entering air temperature ranges specified by AHRI 410.
 - 2. Cooling coil segments will have a full-width IAQ drain pan that extends at least 6" downstream of the last coil in the section.
 - 3. Coils will be removable from the side of unit, via removable AHU panels. No more than one panel must be removed to remove a coil.
 - 4. Coils will have frames constructed of galvanized steel, except cooling coils which shall have stainless steel casings (frame material). Casing channels will be free-draining and do not block fin area.
 - 5. Coil segment door clearances will allow for at least 2-inches of field installed piping insulation.
 - 6. Coil bulkheads and blank-offs will prevent air from bypassing coils.
 - 7. Coil segment casing to accommodate full-face or reduced-face coils will be provided. Provide face and bypass coil segments with factory installed bypass damper
 - 8. A 1/4" FPT plugged vent/drain tap will be provided on each connection. Vent, drain, and coil connections will be extended to outside of AHU casing.
 - 9. Spool shaped coil grommets will be provided to insulate and seal coil penetrations.
 - 10. Water and glycol coils will be designed to operate at 250 psig and up to 300° F and will be factory tested with 325 psig compressed air under water.
 - 11. Water coil tubes will be mandrel expanded to form fin bond and burnished, work-hardened interior surface.

12. Coil fins will be die-formed, continuous aluminum and have fully drawn collars to accurately space fins and form a protective sheath for tubes.

2.9 FILTERS

- A. Filter segments will be provided, as shown on product drawings. Filter tracks/frames will be an integral part of the unit.
- B. Filter media for units delivered in the continental United States will not be shipped with units. Filters will be shipped to a customer defined location. Coordinate filter delivery with sales representatives.
- C. Filter types, nominal sizes, efficiencies, and performance characteristics will be as shown in performance specifications.
- D. Filter access will be provided via access doors on filter segments or adjacent segments as required by filter loading scheme. See product drawings for details.
- E. Flush mounted, factory installed differential pressure gauge on the drive side of unit to measure pressure drop across filters will be provided.

2.10 DAMPERS

- A. Dampers will be factory installed.
- B. Dampers will have airfoil blades with extruded vinyl edge seals and flexible metal compressible jamb seals.
- C. Dampers will have a maximum leakage rate of 4 CFM/square foot at 1" w.g. and comply with ASHRAE 90.1.
- D. Maximum damper torque requirement will be 7 in. lbs./ft².
- E. Damper blades will be parallel acting unless submitted otherwise.
- F. Damper blades will be galvanized steel or aluminum.

2.11 UVC FIXTURES

- A. Fixtures have been tested, listed and labeled as UL/C-UL under Category Code ABQK (Accessories, Air Duct Mounted), UL Standards: 153, 1598 & 1995 respectively.
- B. Fixtures meet the "UL" drip proof design and each fixture is equipped with an electrical interlock.
- C. Each lamp contains no more than 5.5 milligrams of mercury consistent with current environmental practices while producing the specified output at 500 fpm in temperatures of 55-135° F.
- D. Useful lamp life will be 9000 hours with no more than a 20% output loss at the end of one year of continuous use. They are constructed with UVC proof metal bases and will not produce ozone.

2.12 AIR FLOW MEASUREMENT

- A. Provide airflow measurement device and transmitters for the purpose of continuously monitoring unit airflow volume. This includes outside air flow and total air flow as required and building codes. For building automation, return air flows also need to be monitored.
- B. Fan inlet airflow measurements shall be accomplished with the Accutrol Vortek VTFA. The VTFA uses 24V (AC or DC) input power and the device will output airflow via analog output signal or optional BACnet. Analog output offers the total flow of the fan array while BACnet offers individual fan airflow to be summed by the ATC.
- C. Acceptable manufacturers:
 - 1. Vortek VTFA by Accutrol. Provide Ebtron Gold series or Accutrol VTD for duct mount AFMS.

2.13 APPURTENANCES

- A. Safety grates capable of supporting a 300 lb. center load will be provided over bottom openings, as shown in performance specifications.
- B. Formed steel base rails suitable for rigging and lifting will be provided, as shown on product drawings.
- C. Lifting lugs will be provided where required for proper lifting.

2.14 FINISHES

- A. External unit surfaces will be factory cleaned prior to finishing or shipping.
- B. Unpainted air-handling units constructed of galvanized steel will pass the ASTM B-117 test for 220-hour salt spray solution (5%) without any sign of red rust.
- C. Unit will be painted, as shown in performance specifications.
 - 1. Painted units will be prime-coated prior to painting.
 - 2. Paint will be acrylic polyurethane.
 - 3. Painted unit will exceed 500-hour salt spray test, with (5%) solution, without any sign of red rust when tested in accordance with ASTM B-117.

2.15 TESTS AND INSPECTIONS

- A. Fan skid will be run-balanced at specified speed to insure smooth operation.
 - 1. Constant volume fan assemblies will be balanced at design RPM.
 - 2. Variable volume fan assemblies will be balanced from 10% to 100% of design RPM.
 - 3. Filter-in measurements will be taken in horizontal and vertical axes on drive and opposite-drive sides of fan shafts.
 - 4. Constant speed fan vibration limits: filter-in measurements will not exceed 4 mils.
 - 5. Variable speed fan vibration limits: filter-in measurements will not exceed 7 mils.

- B. Unit wiring with voltage greater than 30VAC will be hipot tested prior to shipping.

2.16 ACCEPTABLE MANUFACTURERS

- A. Johnson Controls PACE (Basis of Design)
- B. Or an approved equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air handling unit installation. Replace with new insulation materials and filter media that become wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Mechanical Sound and Vibration Control."
- B. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Mechanical Sound and Vibration Control."
- C. Arrange installation of units to provide access around air handling units for service and maintenance.
- D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- E. Connect duct to air handling units with flexible connections. Comply with requirements in Section 23 31 13 "Ducts & Duct Accessories."
- F. Openings in panels where piping, drives, etc., pass through panels, provide sealed sleeves. Caulk annular space between service lines and sleeves.
- G. Construct field joints in accordance with manufacturer's recommendations. Provide continuous

gaskets and caulk to assure air tightness.

- H. Check all seams and seals around coils and other components for leaks that may have developed in shipment and handling. Seal all leaks airtight in accordance with manufacturer's recommendations.
- I. Locate as indicated. Level unit.
- J. Lubricate bearings for extended shutdown or storage and rotate shafts every four weeks until fans are put into permanent operation. Verify lubrication for bearings and other moving parts prior to fan startup.
- K. Install air handling units with clearances for service and maintenance.
- L. Install ducts adjacent to fans to allow for service and maintenance of fans.
- M. Verify that shipping, blocking, and bracing are removed.
- N. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- O. With fan drive disconnected from wheel, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation after electrical wiring is connected to the motor.
- P. Align and adjust belt tension in accordance with equipment manufacturer's recommendations.

3.3 PIPING CONNECTIONS

- A. Where installing piping adjacent to air handling unit, allow for service and maintenance.
- B. Connect piping to air handling units mounted on vibration isolators with flexible connectors.
- C. Extend condensate drain piping to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring according to Section 26 05 19 "Low Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.5 CONTROL CONNECTIONS;

- A. Install control and electrical power wiring to field-mounted control devices.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- B. Air handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Perform startup service:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that outdoor and return air mixing dampers open and close, and maintain minimum outdoor air setting.
 - 7. Comb coil fins for parallel orientation.
 - 8. Install new, clean filters.
 - 9. Verify that automatic volume control and fire dampers in connected duct systems are in fully open position.
- B. Starting procedures for air handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.

3.8 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing" for air handling system testing, adjusting, and balancing.

3.9 CLEANING

- A. After completing system installation and testing, adjusting, and balancing of air handling unit and air distribution systems, and after completing startup service, clean air handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 DEMONSTRATION

- A. Train Government's maintenance personnel to adjust, operate, and maintain air handling units.

END OF SECTION 23 73 13 13

SECTION 23 73 13 - AIR ROTATION UNITS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Chilled Water Cooling and Hot Water Heating Air Rotation System.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 – General Requirements
- B. Section 23 05 00 – Basic Mechanical Materials and Methods
- C. Section 23 05 48 – Mechanical Sound and Vibration Controls
- D. Section 23 05 53- Identification of Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 – Testing, Adjusting, and Balancing
- F. Section 23 08 13 – Commissioning of HVAC System
- G. Section 23 20 00 – Building HVAC Services Piping
- H. Section 23 21 16 – Hydronic Piping Specialties
- I. Section 23 31 13 – Ducts and Air Duct Accessories
- J. Section 25 00 00 – Chiller Plant Control System
- K. Section 25 00 10 - Hot Water Skid System
- L. Section 25 00 20 – Air Handlers Control System
- M. Division 26 - Electrical

1.3 REFERENCES

- A. National Fire Protection Association (NFPA):
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- B. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - 1. AHRI 410 – Forced Circulation Air-Cooling and Air-Heating Coils.

- C. American Society for Testing and Materials International (ASTM):
 - 1. ASTM B75- Standard for copper tubing pressure application.
- D. Underwriters Laboratories, Inc. (UL):
 - 1. The unit shall be manufactured and installed in accordance with the requirements of the Underwriters Laboratory standard; "Ductless Large Open Building Heating and Cooling Equipment - Category LZPG" and bear the official UL Label.

1.4 QUALITY ASSURANCE

Refer to division 1, General Requirements, and Substitution pPocedure.

1.5 ACTION SUBMITTALS

- A. Submittal Procedures: Submittals of all equipment drawings, schedules and specifications must accompany quote.
- B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- D. Manufacturer's Installation Instructions: Submit/Indicate rigging and assembly.

1.6 INFORMATIONAL SUBMITTALS

Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.7 CLOSEOUT SUBMITTALS

- A. Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing in accordance with Section 01 78 23, "Operation and Maintenance Data".

1.8 QUALIFICATIONS

Manufacturer: Company specializing in manufacturing products specified in this section with minimum fifteen years documented experience.

1.9 WARRANTY

- A. Execution Requirements: Product warranties and product bonds.
- B. Furnish one (1) year manufacturer parts only warranty for all equipment.

PART 2 PRODUCTS

2.1 AIR ROTATION UNIT DESIGN CRITERIA

- A. Drawing Designation: 04 00 SA ARU-1, 2 and 3.
- B. Self-contained, pre-wired unit consisting of cabinet, supply fan, chilled water-cooling coils, hot water heating coils and accessories:
 - 1. The unit shall be designed for indoor mounting. The unit will have the capabilities of heating, cooling, filtering, and circulating as detailed in the submittal drawing.
 - 2. The unit shall be factory assembled and tested prior to shipping, disassembled for shipping, and reassembled on site by the awarded contractor as required.
 - 3. System and accessories to be UL listed and approved as a complete unit.
 - 4. Heating: Draw through hot water heating coils.
 - 5. Unit Configuration: Vertical with horizontal discharge. Units shall have control panel serviceable from ground level.
 - 6. Lifting Provisions: Lifting provisions shall be included on all units as an integral part of the equipment.
 - 7. Supply Voltage: 460V, 3ph., 60 Hz
 - 8. Control Voltage: 120 or 24 volt, 1ph, 60 Hz
 - 9. The unit shall be complete factory wired with a single point electrical connection.
 - 10. All bolting hardware and wiring harnesses shall be furnished, tagged and labeled for ease of installation by the installing contractor.

2.2 MANUFACTURERS

Johnson Air Rotation, substitutions not permitted.

2.3 CASING

- A. Frame Construction: Shall be angle iron framing with 3/16-inch horizontal flange and 1/8-inch vertical framing and factory painted, suitably reinforced and braced to permit the loading, shipping, unloading and rigging to the unit location and general handling of completed sections without damage to external or internal components or misalignment of factory assembled components due to normal handling techniques.
- B. Cabinet Construction: 18-gauge A-60 bonderized steel suitable for factory painting. The panels shall be factory assembled using flat bar screwed construction and have a reinforced steel angle flange assembly. Unit shall be factory painted using factory standard enamel finish.

- C. Insulation: All sections of the Air Rotation unit shall be closed cell injected foam between outer and inner panels of the unit.

2.4 ACCESS DOORS

Access Panels: Hinged access doors in the unit housing shall be provided to permit ready access to all internal components. The access doors shall be a minimum of 18-gauge galvanized steel. The doors shall be designed to swing out. The doors shall be provided with a continuous 16-gauge stainless steel piano hinge. The unit's wall panels shall be an integral part of the doorframe. The unit's fan compartment access for inspection and adjustment shall be UL approved. A warning placard shall be affixed at the access door indicating that the unit is to be shut off before opening the door and entering the fan compartment.

2.5 ELECTRICAL AND CONTROLS

A. Controls

1. The power panel shall have a locking dead front main power cabinet with disconnect and containing necessary fuses, sub-circuits, magnetic starters with 3-leg protection, relays and contactors requiring only a single 3-phase connection.
2. The factory units controls shall be furnished and field installed by the ATC contractor
3. The unit shall incorporate factory-mounted transformers to step down the main power supply voltage to be 120 volts and 24 volts (as required).
4. Variable frequency drive – One per unit shall be per requirements of specification 25 00 20 "Air Handler Control System.
5. Actuator power by ARU manufacturer, manual type.
6. Relative humidity monitoring and re-heat controls shall be furnished and field installed by the ATC contractor.

2.6 FAN(S) AND MOTOR(S)

A. Supply Fans:

1. The supply fans, a minimum of two per unit, shall consist of SWSI type belt-drive plenum fans.
2. Fans shall have the capacity, and class, as scheduled.
3. Blower Shafts - Blower shafts shall be solid ground and polished. The shafts shall not pass through their first critical speed when the unit comes up to the rated RPM. Shaft shall be coated with a rust inhibitor.
4. V-Belt Drives - All V-belt drives shall be standard capacity dual belt type, furnished in matched sets with reinforced rubber belts. The sheaves shall be of a cast iron type.
5. The service factor used for V-belt drive selection shall be not less than 1.25.
6. Lubrication – Extended grease lines shall be provided to the drive size of the fan assemblies.
7. Motors shall Marathon SyMAX Permanent Magnet AC Motors, TENV, 1800 RPM, 460 volt, 3 phase, 60 Hz. Motor horsepower shall be as indicated on the schedule.
8. Supply fans with heating or cooling coils in the 'Blow-Through' configuration are not acceptable.

2.7 HEATING COILS

- A. Hot Water Coil: Designed to withstand 250-psi maximum operating pressure and a maximum water temperature of 300-degrees F (independently):
1. Coils shall be AHRI Standard 410 certification and bear the AHRI symbol.
 2. Coils shall be factory tested at a minimum of 315-PSI air pressure for standard copper tube coil.
 3. Tubing shall be constructed from UNS 12200 seamless copper conforming to ASTM B75 and ASTM B251 for standard pressure application.
 4. Header shall be constructed from UNS 12200 seamless copper conforming to UNS 12200 seamless copper conforming to ASTM B75 and ASTM B251 for standard pressure application. Hot water coil return header shall be equipped with factory installed 1/2-inch FPT air vent connection placed at highest point on the face of the header.
 5. Connection shall be standard construction male pipe thread (MPT) and constructed from red brass conforming to ASTM B43 or schedule 40 steel pipe minimum.
 6. Casing shall be constructed of 16-gauge galvanized steel meeting ASTM A527. Coil shall be installed by manufacture incorporating a pitch of a minimum of 1/8-inch per foot of finned length.

2.8 COOLING COILS

- A. Cooling Coils:
1. Cooling coils shall be placed in a draw through position located in the base section of the unit for ease of maintenance.
 2. Cooling coils shall use 0.020-inch copper tubes and 0.0075-inch aluminum fins. Coil casings shall be 304L stainless steel.
 3. Drain pans shall be triple-pitched for complete drainage and be constructed of all welded 304 stainless steel. The underside of the drain pan shall be completely double-wall insulated with 1.5 inches of spray on foam insulation. Intermediate drain pans (as required) shall be stainless steel and have a stainless-steel downspout to the lower drain pan. The drain pan connection shall be about 8" above the unit base for trapping by the installing contractor.
 4. Face velocity of cooling coils shall not exceed 500 fpm.
 5. Supply fans with cooling coils in the 'Blow-Through' configuration are not acceptable.
 6. Access door(s) shall be provided into base section. Internal walk-on grating shall be provided in bottom of coil section, full-length of unit.

2.9 FILTERS

- A. Mixed Air Filter Frame and Air Filters: Filter frame shall be fabricated of 16-gauge galvanized steel and painted to match the unit's color. Filters shall be upstream service, mounted at floor level for ease of access. Filters will be 2-inch MERV-13.
- B. Filter Maintenance Indication: Dwyer Magnehelic gauge with factory setting to indicate filter change.

2.10 FILTER/MIXING BOX SECTIONS

- A. External mixing box shall be provided upstream of the A/C coils.
- B. Mixing box to have the same construction/finish/insulation as the Air Rotation equipment.

2.11 DAMPERS

- A. Low leak outdoor air dampers with blade and jamb seals (Ruskin CD-60 or equivalent) sized for 660 CFM outside air. Belimo 120V two-position actuators to be provided, mounted, and wired by ARU manufacturer at all outdoor air damper openings.
- B. Low leak return air dampers with blade and jamb seals (Ruskin CD-60 or equivalent) sized for 7,500 CFM return air. Manual hand quadrant included.
- C. Hot water coil bypass dampers sized for 3,750 CFM air bypass. Manual hand quadrant included.

2.12 DISCHARGE

- A. Discharge Louvers:
 - 1. Adjustable horizontal and vertical louvers mounted within a welded frame shall be painted to match cabinet finish.
 - 2. Turning vanes will be factory installed in air discharge section of units.

2.13 ACCESSORIES

- A. Air outlet extension(s), as required, to raise discharge level to 10'0".
- B. UV lights – 17 W/ft² intensity UV lights shall be provided and installed downstream of the A/C coils. Lights shall be powered from unit single point power connection/disconnect. All access door interlock switch(es) by ARU manufacturer.
- C. Freight to job site and factory-assisted start-up services shall be included with all bids.

2.14 IDENTIFICATION AND LABELING

- A. The unit nameplate shall include the unit model number, serial number, Full Load Amps, and supply voltage.
- B. The units shall be permanently marked with the equipment number indicated in the schedules.
- C. All matching pieces of units shipped in sections shall be marked for easy identification of adjoining sections. Lifting points shall be marked.
- D. Proper warning labels for high voltage and moving parts shall be permanently affixed to access doors.

- E. An electrical ladder diagram shall be permanently affixed inside of the electrical control panel. The schematic shall be specific to the project and not be a generic type encompassing features or options not present on the unit. The schematic shall include the fuse replacement values and types.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Receive, set, and assemble the unit complete with factory furnished interconnecting power connections between the load side of the power panel and the fan.
- B. Submit manufacturer's printed installation instructions with operating and maintenance data at completion of work.
- C. Install air-handling unit to provide for adequate service access. Coordinate with other trades to ensure air handling unit does not infringe upon access or service clearances of other equipment.
- D. Lubricate bearings for extended shutdown or storage and rotate shafts every four weeks until fans are put into permanent operation. Verify lubrication for bearings and other moving parts prior to fan startup.
- E. Install ducts adjacent to fans to allow for service and maintenance of fans.
- F. Verify that shipping, blocking, and bracing are removed.
- G. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- H. With fan drive disconnected from wheel, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation after electrical wiring is connected to the motor.
- I. Align and adjust belt tension in accordance with equipment manufacturer's recommendations.
- J. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- K. Connect duct to air handling units with flexible connections. Comply with requirements in Section 23 31 13 "Ducts & Duct Accessories."
- L. Support floor-mounted fan units using vibration control devices as specified in Section 23 05 48, "Mechanical Sound and Vibration Controls." Secure vibration controls to concrete bases using anchor bolts cast in concrete base.
- M. Install floor-mounted fan units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

- N. Openings in panels where piping, drives, etc., pass through panels, provide sealed sleeves. Caulk annular space between service lines and sleeves.
- O. Construct field joints in accordance with manufacturer's recommendations. Provide continuous gaskets and caulk to assure air tightness.
- P. Check all seams and seals around coils and other components for leaks that may have developed in shipment and handling. Seal all leaks airtight in accordance with manufacturer's recommendations.
- Q. Locate as indicated. Level unit.

3.2 COMMISSIONING AND USER TRAINING

- A. Technical Field Service/Start-up Supervision:
 - 1. The services of a factory trained Field Engineer will be provided at no extra cost to Government to supervise placing the system in operation and good adjustment. The Field Engineer will instruct the Government's personnel in good equipment operation, and review maintenance procedures with Government's qualified personnel or representatives.
- B. The start-up shall include but not be limited to:
 - 1. Verification of proper supply power.
 - 2. Verification that electrical terminals are secure.
 - 3. Verification of proper airflow balance.
 - 4. Testing of all safety and operating controls.

END OF SECTION 23 73 13

SECTION 23 73 43 – OUTDOOR CUSTOM AIR HANDLING UNITS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Design, performance, fabrication, testing, cleaning and packaging, shipping, installation and final assembly of custom built-up air handling unit.
- B. Basis of Design Products: Where the Specifications or Drawings name a specific manufacturer's product accompanied by the words "Basis of Design," including make or model number or other designation, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Naming of a Basis of Design product is intended to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification. The drawings indicate the general size, configuration, location, connections and/or support for equipment or systems specified with relation to the other building systems.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 – General Requirements
- B. Section 23 05 00 – Basic Mechanical Materials and Methods
- C. Section 23 05 48 – Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 – Testing, Adjusting, And Balancing
- F. Section 23 08 16 – Commissioning of HVAC Systems
- G. Section 23 20 00 – Building HVAC Services Piping
- H. Section 23 21 16 – Hydronic Piping Specialties
- I. Section 23 31 13 – Ducts and Duct Accessories
- J. Section 23 34 16 – Fans
- K. Section 23 37 13 – Air Outlets and Inlets
- L. Section 25 00 00 – Chiller Plant Control System
- M. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. All equipment or components of this specification section shall meet or exceed the requirements and quality of the items herein specified or as denoted on the drawings and schedule.
- B. Equipment furnished under this specification shall be in accordance with the following industry, association and government codes and standards, as applicable to their design, fabrication, assembly and testing:
 - 1. AMCA 99 Standards.
 - 2. NFPA 70 National Electrical Code.
 - 3. NFPA 90A Standard for the Installation of Air Conditioning and Ventilating System.
 - 4. NFPA 90B Standard for the Installation of Warm Air Heating and Air Conditioning systems.
- C. Fans shall be rated in accordance with the following Standards:
 - 1. AMCA Standard 210 for performance.
 - 2. AMCA Standard 301 for sound and shall bear the AMCA seal.
- D. Motors shall meet requirements of NEMA, IEEE, ANSI, and NEC standard.
- E. Coils shall be rated in accordance with ARI Standard 410 and bear the ARI seal.
- F. Equipment within unit shall be UL listed where applicable.

1.4 ACTION SUBMITTALS

- A. Provide the following detailed information on the equipment proposed. Unit manufacturer shall itemize all deviations from the specified requirements. If not so indicated, unit manufacturer will be required to furnish at no cost to the Government:
 - 1. Equipment data sheets, schedules and sketches.
 - 2. Equipment drawings showing overall unit dimensions, and individual components and section dimensions, weights (shipping & operating), capacities, ratings, fan performance, overall configuration, major component locations, access door locations, duct connection sizes and locations, and shipping split locations.
 - 3. Materials of construction for housing and major components.
 - 4. Cross section details of typical wall, floor and roof construction
- B. Information shall include, as applicable, but not be limited to the following:
 - 1. Airborne and transmitted sound power levels by octave band for unit.
 - 2. Fan manufacturer and performance curves with the operating points clearly indicated. Motor sizes and types. Submit fan curves with specified operating point clearly plotted.
 - 3. Detail coil selections with sizes, rows, fin spacing, face velocity, air & fluid temperatures, flow rates, air & fluid pressure drops, and connection sizes. Submit psychometric chart for each cooling coil with design points and final operating point clearly noted.
 - 4. Shop Drawings - Piping connections, sizes and locations
 - 5. Electrical data, wiring diagrams, and accessory panel layouts. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed. Also include point to point wiring diagrams.
 - 6. Construction details including methods of fastening panels, assembling sections, thermal and galvanic break techniques, and materials of construction.

7. (If applicable) Factory testing procedures for review and acceptance.
8. Door and window sizes and elevations.
9. Controls:
 - a. System wiring diagrams with sequence of operation for each system as specified.
 - b. Submit manufacturer's product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications. For complete detail of Controls requirements see Division 25, Intergrated Automation

1.5 INFORMATION SUBMITTALS

- A. Submit manuals with detailed description of installation, operation, and maintenance, including the following:
 1. Written recommendations for field storage, both indoors and outdoors.
 2. Installation requirements including assembly instructions, lifting requirements and adjustments.
 3. Manufacturer's literature describing each piece of equipment including operation instructions with step-by-step preparation of starting, shutdown, and draining and maintenance instructions including lubrication.
 4. Detailed commissioning procedures.
- B. Submit the following detailed information prior to shipment:
 1. Fan/Motor assembly vibration test results.
- C. Submit the following detailed information after field testing:
 1. Air handler casing leakage test results by unit manufacturer.
 2. Fan performance test result by TAB contractor.
 3. Panel deflection test results by manufacturer.

1.6 PRODUCT CLEANING, DELIVERY, STORAGE, AND HANDLING

- A. All equipment shall be delivered to the job site suitably packaged and protected for overland trucking. In general, units shall be delivered in one piece unless otherwise indicated. Where building constraints, unit size or trucking limitations require that unit ship in more than one piece, the manufacturer shall indicate split points on shop drawings.
- B. Thoroughly clean equipment, components and subassemblies of water, dirt, debris, weld splatter, grease, oil and other foreign matter prior to shipment.
- C. Unit shall be prepped and completely sealed for protection during shipment:
 1. Seal closures, caps and plugs dust-tight and moisture-tight.
 2. Protect pipe flanges with plywood coverings; protect pipe threads with plastic end caps or plugs.
 3. Protect machined surfaces with suitable, easily removable rust preventive.
 4. Provide full charge of proper lubricant for grease lubricated bearings.
 5. Provide desiccant bags or vapor phase inhibitors where required to keep components dry.

- D. Ship all air handlers with complete protection from rain and dirt. Air handlers shipped on open trailers shall be protected with a minimum of two (2) layers of heavy mill shrink wrap plastic.
- E. Units delivered with scratched, dented, or dirty surfaces or damage of any type shall be restored to "as new" condition as directed by the Contracting Officer's Representative (COR) at no cost to Government.
- F. If equipment is to be stored before use, shipping protection provided by the unit manufacturer shall remain on the unit until the unit is installed. Manufacturer shall submit written recommendations for field storage.
- G. Provide non-corrosive nameplate permanently attached to the equipment containing the following information:
 - 1. Manufacturer's project/serial number
 - 2. Plant name and location
 - 3. Customer equipment number
 - 4. Date of manufacture
- H. Provide lock down equipment for all vibration isolation during transport and handling.

1.7 WARRANTY

- A. All equipment, materials, and workmanship shall be warranted for (18) months from official turn over. During the warranty period, the manufacturer shall repair or replace, at no additional cost to the Government, any equipment, material, or workmanship in which defects may develop.
- B. Warranty is for parts only.
- C. Unit casing, structural base and roof shall be warranted against corrosion or failure under normal operating conditions for a period of forty (40) years from the date of unit delivery.

PART 2 PRODUCT

2.1 MANUFACTURERS

- A. Provide air handling units as manufactured by:
 - 1. Air Enterprises
 - 2. Ingenia (Basis of Design)
 - 3. Miller Picking.
- B. Alternate pricing based on pre-approved manufacturers will be considered if the manufacturers meet all performance and construction techniques of the specified basis of design.. Any substitutions shall be approved by the COR in writing ten (30) days prior to bid.
- C. The unit manufacturer shall have been manufacturing custom built-up air handling units for a minimum of 10 years and provide references if requested.

2.2 CUSTOM AIR HANDLING UNITS GENERAL

- A. Drawing Designation: 04 10 SA AHU-1, 2, 3, 4, 5, 6, and 7.
- B. Custom built units shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.
- C. Classification as designated by the unit manufacturer or minimum requirement selected below:
- | | |
|--------------------------|-------|
| 1. Total Static Pressure | Class |
| a. Up to 3.75 inches WC | I |
| b. Up to 6.75 inches WC | II |
| c. Up to 12.75 inches WC | III |
- D. The units shall be constructed for outdoor installation on structural steel dunnage. Outdoor units shall be provided with weatherproofing (roofing, guttering, etc.) as defined herein. All outdoor units shall be stainless steel exterior or powder coated aluminum. Powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @400 degrees F; Electrostatic paint application (powder format); Baked finish @ 400 degrees F. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece shall retain its charge, which holds the powder to the work piece. The coated work piece shall be placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOS's), hazardous air pollutants and solvents. Individual panels shall be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The coating shall resist 1000 hours to the standard ASTM-B117 scratch salt spray test and resist 10,000 hours to the standard ASTM-B117 exposure salt spray test.
- E. The units shall consist of: intake sections for return and outdoor air, mixing section with dampers for outdoor air, return air, pre-filter section, final filter section, heating coil sections, cooling coil section, humidifier (high pressure water atomizing) section, supply fan section and discharge section.
- F. Units shall be provided with a complete LED lighting system with switches and receptacles in weatherproof enclosures. Junction boxes and distribution panels shall be NEMA 4X. Damper operators furnished and installed on all dampers by the ATC contractor. Motor wiring to NEMA 4X safety disconnect switches by unit manufacturer. LED fixtures shall be equivalent to RAB Lighting SHARK4-50W/D10. Provide outdoor LED fixtures at vestibule entrances equivalent to RAB Lighting. Outdoor LED fixtures shall be controlled by photocell.
- G. As a general rule, the unit shall employ aluminum or stainless-steel materials (panels, bases, supports and safing) to maximize cleanliness of the conditioned air, facilitate and simplify maintenance and ensure longevity of the unit by eliminating rust potential.

- H. Provide safing between internal components and unit casing to prevent air bypass. Safing material shall match unit interior. All seams or voids between safing, components and unit casing shall be caulked and sealed airtight.
- I. Provide hygienic unit design with interior suitable for washing down without any vapor or water transfer into the wall or base cavities. Unit insulation shall be closed cell foam. This requirement is due to the incidence of mold growth with fiberglass or open cell foam insulation when it gets wet.
- J. The unit is shall be shipped factory assembled in one complete section, when possible. If necessary to ship the unit in sections, due to rigging or shipping constraints, the unit shall be designed to minimize the number of sections. The unit manufacturer shall provide field erection supervision for joining of unit module sections.
- K. The custom unit shall fit and accommodate all constraints and still enable access to all components for maintenance and cleaning.

2.3 UNIT BASE

- A. The unit shall be constructed on an all- 304 stainless steel structural base for outdoor applications. The base shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning.
- B. The base floor shall be minimum 8-gauge 304 stainless steel plate. Floors shall be guaranteed air and water tight. Floor material shall have safety-tread surface in areas where people will be walking. The base floor shall be designed for a minimum live load of 150 pounds per square foot throughout the unit. The base floor is to be supported with adequate stiffening members to prevent oil canning. Caulking or gaskets to guarantee seals and water tightness of joints will not be acceptable.
- C. The perimeter support members shall be properly sized to support all major components and the housing during rigging, handling and operation of the unit.
- D. The underneath side of the base pan and base perimeter shall be insulated with injected or sprayed closed cell foam of proper R-Value to prevent any condensation beneath the unit. Fiberglass batt insulation is not acceptable. Supplier shall demonstrate through thermal modeling or actual testing that no condensation will occur at the specified ambient temperatures and humidity where the AHU will be located.
- E. Each section of the unit base shall contain a minimum 1-1/2-inch NPT drain to facilitate system wash down, maintenance and/or condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Clean out drains shall be provided with removable caps of non-corrosive material. . Provide a 2-inch high lip at floor to wall joint, to provide a waterproof floor capable of holding 2 inches of water without leaking. Any drain pipes in the Unit Base needs to be pitched a minimum of 1/4-inch per foot. All unit drain piping shall be schedule 40 stainless steel.
- F. All equipment within air handling unit shall be provided with a minimum 1-1/2-inch-high base to raise equipment off unit floor for housekeeping. Equipment mounted directly on unit floor is unacceptable.

- G. Supply air openings to be framed with 2-inch-high water dam continuously welded or mechanically joined to the pan to allow proper duct connections and to prevent moisture from entering the openings. Framed openings shall be provided with removable 304 stainless steel grating designed and fabricated for a live load of 100 pounds per square foot. Galvanized or painted steel grating will not be accepted.
- H. All unit base service openings shall be framed with a minimum 2-inch-high water dam continuously welded or mechanically joined to the floor. All pipe and electric conduit chases with openings to building or elements shall be covered with thin gage 304 stainless steel. Penetrations by contractors shall be minimized. If required, they shall be sealed by the respective contractor and proved in the field to be leak free.
- I. Fastening to floor plate or joining of unit sections shall be accomplished by bolting through gasketed joints above the floor line, butyl rubber membrane with pressure plates or continuously welding.
- J. Unit shall be provided with properly located removable lifting lugs for each section to adequately allow rigging of the unit sections in place.
- K. Unit Base shall be provided with mounting holes to secure it to the floor or structural steel to prevent movement created by seismic conditions. Base plates and bolt patterns shall be provided in such a manner that the forces are evenly distributed over the base of the unit.

2.4 CABINET

- A. Complete "no metal through construction (thermal break)" in all locations to prevent condensation and subsequent mold growth from occurring. The thermal break shall consist of a minimum 1/2-inch structural non-metallic bridge. Adhesive tapes or gaskets do not constitute an acceptable thermal break.
- B. Unit Casing shall be built up from the unit base with load bearing panels. Panels shall be capable of forming the enclosure without additional structural members. Structural members are acceptable in some instances. Panels shall be joined together with independent joining member and fastened with closed end stainless steel fasteners. Plated fasteners will not be accepted.
- C. Each panel shall contain an integral frame or be properly supported by a structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation to guarantee structural integrity and no moisture getting inside the panel.
- D. The panel thickness shall be dictated by the R-value required to prevent any exterior condensation, and meet the structural stiffness and noise specification. All insulation shall be closed cell injected foam. At a minimum, outdoor units should have R-value of 19. Noise and stiffness requirements along with Federal energy code may dictate thicker walls with higher R-values. Under normal operating design conditions, there shall be no condensation on the unit exterior at an ambient condition of 115 degrees F DB, 80 degrees F WB
- E. Thickness of the panel skin, core density, rib structural frame spacing shall be regulated to eliminate panel pulsation and restrict the maximum deflection to L/250 of any span at design load of 1-1/2 times the design positive or negative pressure plus snow and wind loading. The

maximum deflection of roof and floor shall be $L/360$ at design loading. Deflection is worst case at the center of the panel

- F. Casing system shall be guaranteed to assure the Government that system capacity, performance, and cleanliness standards specified are not compromised. Leakage shall be guaranteed at no more than 0.5 percent of the design volume at 1-1/2 times the design operating pressure or 30 CFM, whichever is greater. Sections of casing shall be pressure tested in pressure mode (negative or positive) which they will normally operate. For example, the suction side of the fan should be pressure tested with negative pressure differential. The units shall be tested prior to shipping. A Government's representative shall witness the test. Manufacturer shall provide for expenses of one Government's representative to witness the test with a minimum two-week notice.
- G. All casing walls shall be of panel construction, including but not limited to the fan discharge walls, mixing section walls and divider wall to the access corridor.
- H. Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable. Air handlers shall have no through metal constriction.
- I. Pipe and conduit penetrations through the unit casings shall be provided by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations sealed by simply caulking around extension are not acceptable.
- J. Provide minimum 24 inches wide access doors for access to all internal components. Access doors shall be installed to open against the greatest pressure relative to air pressure on each side of access door. Where this is not feasible, an interlocking mechanism is required to prevent damage or injury:
 - 1. Access doors shall be of the same construction as panels described above. This includes the thermal break requirements.
 - 2. The door seals shall be made of a 2-component formed-in-place foam gasket (FIPFG) material. The application process shall be by means of a liquid polyurethane high pressure injection, providing a continuous seamless gasket. The non-powder coated gasket base surfaces shall be prepped with an ethanol-based primer prior to application of the liquid polyurethane. Powder coated surfaces do not require a base primer.
 - 3. Each access door shall contain a thermo pane safety glass window (min. 10 inches square).
 - 4. If fan blades are exposed during operation an OSHA approved interlock switch is required on the door which de-energizes the fan before entry. Provide door interlock switch(s) to disable UV lighting system. Fan guarding is also acceptable.
 - 5. Provide 1 inch dia. test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement.
 - 6. Each access door shall be mounted with stainless-steel hinges and shall have a least two (2) non-corrosive handles operable from either side. Handles need to be at an acceptable height when standing outside the unit. Exterior AHUs shall utilize stainless steel door hardware for doors subjected to an outdoor environment.
- K. Removable access panels shall be provided as appropriate for service and maintenance. They shall be sized appropriately for the component that is being replaced or repaired. Access panels shall be of the same construction as panels described above. Removable access panels shall

be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels. Airtight integrity shall be maintained.

- L. For large internal components such as fans and motors, install structural I-beam so hoist mechanism can be used to safely lift and remove the component from the unit casing.
- M. Materials:
 - 1. Exterior – Outdoor Units powder coated Stainless Steel. Polished 304 stainless steel interior panels.

2.5 EXTERIOR & INTERIOR FINISH

- A. The interior surfaces of the air handler shall be 304 polished stainless steel.
- B. The Interior finish shall be polished 304 stainless steel.
- C. The powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @ 400 degrees F; Electrostatic paint application (powder format); Baked finish @ 400 degrees F.
- D. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece retains its charge, which holds the powder to the work piece. The coated work piece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOC's), hazardous air pollutants (HAP's) and solvents. Individual panels shall be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 1000 hours to the standard ASTM-B117 scratch salt spray test and resist 10,000 hours to the standard ASTM-B117 exposure salt spray test.

2.6 ROOF SYSTEM

- A. Unit roofs for outdoor units are to be sloped a minimum of 1/4 inch per foot to ensure positive run-off. Roof shall peak in center and drain off to both sides.
- B. The roof system shall be constructed of powder coated 304 stainless steel. The roof panel s shall be interlocked standing seam construction or a cladding roof system. The use of a membrane roofing system is prohibited. No fasteners shall be vertically installed in roofing system.

2.7 OUTDOOR AIR SECTION

- A. Weather hood exterior shall match the finish of the unit casing
- B. Bird screen: stainless steel mesh.

- C. Outdoor air intake shall be sized minimize snow intake.

2.8 MIXING SECTION

- A. Complete with framed openings with low-leakage outdoor and return air dampers. Dampers shall be as specified below and shall be furnished and installed by the unit manufacturer.
- B. Mixing section shall be designed for controlled mixing in that the proximity, relation, and air velocity for each respective damper shall be such that volume swings and stratification will be eliminated.
- C. Outdoor air damper banks can be handled in one of two ways. First, incorporate a two-position minimum outdoor air damper and a second independent modulating outdoor air damper. Second option, use of one OA damper. Minimum outdoor air provided by controlling outdoor air damper bank to a minimum position. Outdoor air shall have flow station(s) as a means of demonstrating compliance for outdoor air intake. Air flow station shall be per requirements of section 25 00 20 "Air Handlers Control System"
- D. Mixing should eliminate possibility of air stratification where cold outdoor air can freeze chilled water coil or an air blender needs to be incorporated into the design.

2.9 FILTER SECTIONS

- A. Provide all pre-filters and final filters of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications. Filters shall be selected for a maximum face velocity of 500 fpm.
- B. Filters shall have nominal rating of 500 fpm. Each cell shall be 24 inches x 24 inches, or 12 inches x 24 inches. Media shall be approved and listed as Underwriters Laboratories Class 2 when tested according to UL Standard 900 and as described below:
 - 1. Pre-filters: 2-inch thick MERV 8 efficiency, equal to AAF PerfectPleat HC M8.
 - 2. Final Filters: 12-inch rigid pleated V-type, MERV 14, equal to AAF VariCel RF.
 - 3. HEPA Filters: 99.99% (when tested with 0.3 micron thermally generated particulates) high volume capacity HEPA filters tested and certified, equal to AAF SuperFlow 24.
- C. Filters shall be upstream removable (face mounted). Side access is not acceptable. Pre-filter sections shall be complete with holding frames capable of holding pre-filters with high efficiency filters. Pre-filters shall be capable of being removed and installed without affecting seal of the high efficiency filter.
- D. Filter frames shall be aluminum construction. Filter frame gaskets shall be made of a 2-component formed-in-place foam gasket (FIPFG) material. The application process shall be by means of a liquid polyurethane high pressure injection, providing a continuous seamless gasket. The non-powder coated gasket base surfaces shall be prepped with an ethanol-based primer prior to application of the liquid polyurethane. Powder coated surfaces do not require a base primer. No gaskets needed on filter frames where filters are purchased with gaskets (HEPA filters ONLY). Filter holding frames shall be installed and individually sealed to prevent leakage around frames. Filter banks shall be reinforced with vertical stiffeners to assure rigidity for up to 3.5-4 inches pressure differential. Unit manufacturer shall provide flashing between filter banks

and unit casings to prevent air leakage or bypass around the frames. Installation techniques, sealing methods, and structural reinforcement shall eliminate unfiltered air bypass and ensure system cleanliness based on filter efficiencies specified.

- E. Unit manufacturer shall provide and install a Dwyer series 2000 magnehelic gauge complete with stainless steel static pressure tips and accessories for indicating the operating pressure drop of each filter bank. Indicating range of gauge shall be selected at two times the final resistance of the filter bank. Provide hose barbs to connect indicating transmitter to the control system.
- F. Unit manufacturer shall provide (2) sets of pre-filter media and (2) sets of final filter media, and (1) set of HEPA filter media.
- G. Acceptable filter frame manufacturers are as follows:
 - 1. Pre-filter and Final Filter: Camfil-Type 8, Ingenia
 - 2. HEPA filter: Camfil-Magnaframe, Ingenia

2.10 HEPA FILTERS

- A. The final filters shall be HEPA high volume type. Only approved HEPA framing system shall be used. Air filters shall be HEPA grade high-volume air Filters (24 x 24 rated for 2400 CFM at 1.0 inches w.g.) with waterproof micro glass fiber media, urethane sealant, anodized extruded aluminum frame, and neoprene sealing gasket. Filter media shall be one continuous pleating of micro glass fiber media mini-pleated. Overall dimensional tolerance shall be correct within -1/8 inch, +0 inches, and square within 1/8 inch. A poured-in-place seamless sealing gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.
- B. The filter shall have a tested efficiency of 99.99 percent when evaluated under the guidance of IEST TEST A Recommended Practice RP-CC001. The Initial resistance to airflow shall not exceed 1.0 inches w.g. at rated capacity. Filter shall be rated by Underwriters Laboratories. The filter shall be capable of withstanding 10 inches w.g. without failure of the media pack. The filter shall be labeled as to tested efficiency, rated/tested airflow, pressure drop and shall be serialized for identification.

2.11 COIL SECTIONS

- A. HEATING COIL
 - 1. Each coil shall have been hydrostatically tested up to 150 psig for temperatures ≤ 200 degrees F and shall be designed for continuous operation at 200 psig and 220 degrees F.
 - 2. Water coils shall have copper headers and red brass threaded connections. Drain and vent connections shall be incorporated into the header and extended to the exterior of the casing.
 - 3. The coil frame material shall be 304 stainless steel.
 - 4. The tubes shall be copper with a nominal diameter of 5/8 inch and 0.035-inch-thick wall.
 - 5. Heat transfer fins shall be aluminum and shall have a nominal thickness of 0.010-inch.
 - 6. Reheat coils shall be provided as scheduled and all supply, return and vent piping shall be terminated in the service vestibule. Extended piping for far side coils by contractor.

7. Preheat coils shall be provided as scheduled and all supply, return and vent piping shall be terminated in the service vestibule.
8. Provide coil racks that allow for individual coil removal without disturbing other coils. Racks to be constructed of 304 stainless steel.

B. COOLING COIL

1. Water coils shall have copper headers and red brass threaded connections. Drain and vent connections shall be incorporated into the header and extended to the exterior of the casing.
2. The coil frame material shall be stainless steel.
3. The tubes shall be copper with a nominal diameter of 5/8 inch and 0.035-inch-thick wall.
4. Heat transfer fins shall be aluminum and shall have a nominal thickness of 0.010-inch.
5. Where noted the cooling coil section shall be arranged in a face and bypass arrangement. The coil shall have a face damper while the space above the coil shall have a bypass damper that fills the available space. Dampers shall be equal to TAMCO series 1000 and actuators shall be furnished and installed by the ATC contractor.
6. Space shall be allotted between the cooling coil section access door and the door serving the fan inlet plenum for future installation of air blenders.
7. Provide coil racks that allow for individual coil removal without disturbing other coils. Racks to be constructed of 304 stainless steel.
8. Coil racks to include 304 stainless steel intermediate drain pans for stacked coils.

2.12 SUPPLY FAN SECTIONS

A. General Guidelines are as follows:

1. Provide fans, motors and drives of number, size and capacity as required and appropriate for the application. Design shall incorporate the number of fans indicated the drawing schedules to maximize efficiency and meet the redundancy specification. Selecting the least number of fans that meet the redundancy requirements will normally produce the most efficient system design.
2. Reference Standard 23 34 16 – Fans for general info on construction and performance.
3. System effects shall be carefully evaluated to ensure no excessive efficiency losses.
4. Direct drive fans are required.
5. All motors shall include isolated bearings or shaft grounding to prevent premature bearing failure due to VFD induced electrical damage.
6. Performance: Performance ratings shall conform to AMCA standard 205 (fan efficiency grade), 211 (air performance) and 311 (sound performance). Fans shall be tested in accordance with ANSI/AMCA Standard 210 (air performance) and 300 (sound performance) in an AMCA accredited laboratory. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air and fan efficiency grade (FEG).

B. FAN ARRAY SYSTEM

1. The Fan Array system shall consist of multiple, direct driven, arrangement plenum fans constructed per AMCA requirements, Class III.
2. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans shall have a non-overloading design with self-limiting horsepower characteristics and shall reach a peak in the normal selection area. All fans shall be capable

- of operating over the minimum pressure class limits as specified in AMCA's Standard 2408-69.
3. PERFORMANCE - Fans shall be tested in accordance with AMCA 211 and AMCA 311 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air.
 4. Performance data on fans with shaft, bearings, and bearings bar in the inlet shall be de-rated to account for inlet restrictions and shall be licensed to bear the AMCA certified ratings seal for both sound and air.
 5. CONSTRUCTION – Fans shall be designed without a scroll type housing and shall incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge reinforced steel inlet plate, structural steel frame, and shaft and bearings.
 6. FRAME AND INLET PLATE – Inlet plates shall be of heavy-gauge reinforced steel construction. The inlet plate incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel. A square, formed lip suitable for attachment of a boot connector shall surround the unit, or an optional round inlet collar can be provided.
 7. WHEEL – Wheels shall have a spun non-tapered style blade, retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. Sizes 245 and smaller shall have airfoil-shaped extruded aluminum blades. Sizes 270 and larger shall have die-formed airfoil steel blades with the option of extruded aluminum blades. All wheels on direct drive arrangement 4 fans shall have airfoil-shaped extruded aluminum blades. All hollow blade wheels shall be continuously welded around all edges. Wheels shall have nine blades for high efficiencies. All wheels shall be statically and dynamically balanced on precision electronic balancers to a level of G6.3 (per ANSI 2019) or better.
 8. FINISH AND COATING – The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust-preventive primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum-based rust protectant. Aluminum components shall be unpainted.
 9. FAN MANUFACTURER FACTORY RUN TEST - All fans prior to shipment shall be completely assembled and test run as a unit at the specified operating speed or maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained, and a written copy shall be available upon request.
 10. Each fan/motor cartridge shall be rigidly mounted on 1 inch deflection vibration isolators and balanced as an assembly to 0.12 inches / second filter in.
 11. For all fan arrays, maximum individual motor size is 25 HP.
 12. Fan wheels shall be aluminum airfoil type with minimum 9 blades, and fully welded.
 13. The fan array shall be provided with acoustical liners that reduce the bare fan discharge sound power levels. The silencers shall not increase the fan total static pressure, nor shall they increase the airway tunnel length of the Air Handling Unit when compared to the same fan array unit without the silencer array.
 14. Manufacturers shall submit acoustical data for review and approval prior to the bid indicating that the proposed alternate equipment can meet all specified performance requirements without impacting the equipment performance or design features including duct connection location, unit weights, acoustical performance, or specified total fan HP for each fan array. Proposals submitted which indicate a higher connected fan HP than specified or scheduled will not be accepted.

15. The fan array shall consist of multiple fan and motor "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
 16. The Fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12 inches from the intake side of the Fan array intake plenum wall, and at a distance of 48 inches from the discharge side of the Fan plenum wall.
 17. Each fan/motor "cell" shall be provided with an individual back-draft damper. Backdraft dampers shall be extruded aluminum on frames and blades and engineered to produce minimum static pressure loss at the designed operating conditions. Seals shall be solid rubber. Bearings shall be rubber shielded radial ball bearings, permanently lubricated.
 18. Provide a sliding motor removal rail in all fan sections.
 19. Each fan motor shall be wired to a factory mounted and wired NEMA 4X disconnect switch. a Government supplied VFD shall be shipped to the AHU manufacturer for installation and wiring within the service vestibule.
 20. Acceptable fan manufacturers:
 - a. Twin City Fan (Basis of Design)
 - b. Greenheck
 - c. New York Blower
- C. MOTORS: shall be 1750 RPM, 460V/3ph/60Hz as per the following:
1. Motor shall be true synchronous speed, permanent magnet technology, IE4+ efficient totally enclosed fan cooled (TEFC) rated for severe duty or higher.
 2. Motor shall be of HP as listed on schedule. The motor service factor shall be a minimum of 1.0. and an efficiency IE3 when operating on a VFD. Motor shall be selected to provide adequate torque throughout entire range of fan operation and not exceed nameplate HP when fan operates at synchronous motor speed.
 3. Motor shall be designed for continuous duty operation, NEMA Design B with class H insulation.
 4. The motor shall be suitable for operating with variable frequency drives without undue noise, vibration or deterioration of reliability and life.
 5. Motors shall be "Inverter Duty Rated" per NEMA Std. MG1 part 31.4.4.2 and labeled as such.
 6. Variable frequency PWM driven motors shall include a circumferential, conductive micro fiber shaft grounding ring or equivalent shall be installed on the AC motor to discharge shaft currents to ground.
 7. Provide stainless steel nameplate indicating the following:
 - a. NEMA efficiency index nominal efficient (MB1-12.53BO).
 - b. AFBMA bearing numbers.
 - c. Lubrication instructions.
 8. Acceptable motor manufactures:
 - a. Baldor, RPM XE eXtreme Efficient Motors (10 HP and above)
 - b. Marathon Three Phase SyMax Permanent Magnet Motors (Below 10 HP)
 9. The use of EC motors is prohibited.

D. FAN MOTOR LIFTING AND HANDLING RAILS

1. Fan/motor sections with motors shall include lifting rails to facilitate the lifting and handling of the motor to the exterior of the AHU cabinet.
2. The rails shall include an extendible mechanism to ensure that the motors can be handled to the exterior of the AHU cabinet.
3. By means of columns and beams, the system load shall be transferred to the AHU floor framing system.
4. Lift trolley shall be included with the unit by the unit manufacturer.

2.13 CONTROL DAMPERS

- A. Dampers shall be low leakage type with flexible seals for frame and blades.
- B. Dampers shall be sized appropriately without blanking off free areas
- C. Damper shall be capable of withstanding 5.0" WC differential pressure at specified fpm approach velocity.
- D. Damper shall be maintenance free, other than yearly wipe down. Damper shall have concealed linkages. No lubrication shall be needed for bearings or linkages. Bearings are composed of a Celcon inner bearing - fixed around a 7/16" aluminum hexagon blade pivot pin - rotating within a polycarbonate outer bearing inserted in the frame. This eliminates action between metal-to-metal or metal-to-plastic riding surfaces..
- E. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures.
- F. Outdoor air damper banks can be handled in one of two ways. First, incorporate a two-position minimum outdoor air and an independent modulating outdoor air damper. Second, minimum outdoor air provided by controlling outdoor air damper bank to a minimum position. Outdoor air shall have flow station as a means of demonstrating code compliance for outdoor air.
- G. Damper actuators shall be provided and mounted by (ATC Contractor). Actuators for dampers with modulating control to be provided with position feedback (4-20 ma).
- H. Damper should be appropriate for the application. Outside air damper should be designed to prevent freeze-up and reduce condensation. Maintenance free oiled bronze bearings preferred.
- I. Acceptable dampers: Low Leakage TAMCO Series 1000 or Ruskin model appropriate for the application. OA dampers shall be equal to TAMCO 9000 series, thermally insulated type. Where OA airflow measurement is required provide TAMCO/EBTRON Series 2900 AIR-IQ2 damper with integral airflow measurement.

2.14 DRAIN PANS

- A. Condensate drain pan shall be Indoor Air Quality compliant complying with ASHRAE Standard 62.1-2019 Ventilation for Acceptable Indoor Air Quality.
- B. Fabricated from minimum thickness 16-gauge 304 stainless steel

- C. Absolutely no standing water allowed to accumulate in the pan.
- D. Minimum 1 1/2-inch drain connection at lowest point in the pan.
- E. Coils shall be mounted on supports above drain pan. Coil supports cannot prevent water drainage.
- F. Air cannot bypass around coil through drain pan.

2.15 AIR FLOW MEASUREMENT

- A. Provide airflow measurement device and transmitters for the purpose of continuously monitoring unit airflow volume. This includes outdoor air flow, return air flow, and total air flow.
- B. Fan inlet flow measurements shall be accomplished the Accutrol Vortek VTFA. The VTFA uses 24V (AC or DC) input power and the device shall output airflow via analog output signal or optional BACnet. Analog output offers the total flow of the fan array while BACnet offers individual fan airflow to be summed by the ATC.
- C. Acceptable manufacturers:
 - 1. Ebtron or Vortek VTFA by Accutrol. Provide Ebtron Gold series or Accutrol VTD for duct mount AFMS.

2.16 ULTRAVIOLET LIGHTS

- A. Independent Testing – All UV-C fixtures shall have been tested and labeled as UL Listed.
- B. Fixtures – Fixtures shall be HVACR style high output (HO) types optimized for both heating and cooling temperatures of from 1-70 degrees C, in air streams of 750 fpm. Fixtures shall be constructed of hospital grade (304) stainless steel and shall be capable of being mounted anywhere in the system and/or as shown on the plans. Each fixture shall be constructed with mounting holes, weep holes, and 6-1/2-inch electrical knockouts, 3- at each end, to facilitate installation.
- C. Power Supplies - Power supplies shall be completely waterproof and be of the high efficiency electronic type, matched to the lamp and designed to maximize UV-C photon production, lamp irradiance, energy efficiency and reliability. They shall be waterproof and UL Listed and labeled for use in air-streams of 1-70 degrees C. They shall be capable of producing the specified output and organism destruction as specified under Intensity using no more than 10 Watts of power consumption for each square foot of treated, cross-sectional plane.
- D. Lamps – Lamp Watts shall be printed clearly on all lamps. Lamps shall be high output (HO), T5 diameter, rapid-start, medium bi-pin types that produce UV-C of 254 nm. Each lamp shall contain no more than 8 mg of mercury and shall be capable of operating in air temperatures of 1-70 degrees C and velocities to 750 fpm. Useful lamp life shall be 9000 hours with no more than a 20 percent output loss at the end of lamp life when used continuously. They shall be constructed with UV-C resistant bases and shall not produce measurable ozone.

- E. Irradiation - Lamps and fixtures shall be installed in sufficient quantity and in such a manner so as to provide an "equal" distribution of UV-C energy within the irradiated plenum. When installed, the UV-C energy shall be of the lowest possible reflected and shadowed losses.
- F. Intensity - The minimal UV-C energy striking all surfaces shall at all times be sufficient to continuously destroy surface mold and bacteria as typically found in HVAC systems.
- G. Installation – When used for surface irradiation, the fixture assembly shall be designed and installed such that the sum of the fixture row lengths shall be equal to a minimum of 90 percent of the coil surfaces width. Fixture rows shall be electrically terminated in accordance with both NEC and local codes. Fixtures shall be mounted to irradiate the intended surface(s) as well as all of the available line of sight airstream by proper placement and incident angle reflection.
- H. Safety – UV-C system On/Off switches shall be installed on the exterior of all UV-C plenums next to the plenum access door. Mechanical interlock switches shall be installed on all access panels and doors to the UV-C plenums to ensure that the UVC fixtures will be de-energized when any of these accesses are opened. Provide CT switches on each ballast as shown on the P&ID drawings for lamp monitoring.
- I. Acceptable manufacturers:
 - 1. Steril-Aire
 - 2. UV Resources
 - 3. FRESH-AIRE UV.

2.17 HIGH PRESSURE WATER ATOMIZATION TYPE HUMIDIFIER

- A. Drawing Designation: 04 03 RO HUM-1, 04 03 SA HUM-1, 2, 3, 4, 5, 6, and 7.
- B. General: Provide high pressure water atomization type humidifier including the following components:
 - 1. Fog nozzles.
 - 2. Fog pump unit(s)
 - 3. Water treatment equipment (using RO treated water).
 - 4. Fog nozzle manifolds and main feed lines.
 - 5. Droplet Filters and frames
 - 6. Electrical panels and automatic control valves.
- C. The system component sizes and capacities shall meet the specified load for humidification zones.
- D. High pressure humidification system shall not use more than 0.003 kW/# of moisture generated.
- E. Fog Nozzle Section:
 - 1. Nozzle: 316 stainless steel construction with a 0.008-inch machined orifice.
 - 2. Median droplet size to be between 10-40 microns with 95 percent of the droplets at 15 microns or less at 1,000 psig operating pressure.
 - 3. The nozzle manifold to be constructed of 1/2-inch OD 316 stainless steel tubing with 0.035-inch wall thickness.

4. Nozzle saddles to be TIG welded to the manifold.
5. All connections between tubing to be 316 stainless steel double-ferrule compression fittings.
6. Nozzle section in AHU shall be non-corrosive and include a stainless-steel drain pan that slopes to the drain.

F. High pressure water pump units:

1. Drawing Designation: 04 03 RO PMP-1 and 04 03 RO PMP-2
2. Complete fog pump units shall include the following:
 - a. Oil lubricated ceramic plunger pumps with stainless steel heads: Water lubricated axial piston pumps are not to be used due to noise and vibration.
 - b. Direct drive connection to the motor. Belt driven not to be used.
 - c. Frame: Components to be mounted on a 304 stainless steel frame.
 - d. Allen Bradley PowerFlex 755 VFD with pressure transducer to maintain pump pressure.
 - e. Pump system shall be rack mounted and fully assembled at the factory. The factory mounted equipment includes pumps, VFD's, filters, and associated control panels. Rack shall be fully tested at the factory prior to shipment. Pump System PLC Shall be Allen Bradley MicroLogix 1400 PLC. Fog pump controls shall meet Division 25 Specifications and requirements of P&ID drawings.
 - f. Pressure regulating valves: Stainless steel construction with stainless steel valve and valve seat.
 - g. Electric motors shall be TEFC, Inverter duty premium efficiency model.
 - h. Pump unit shall be capable of operating minimum zone without overheating of pump.
 - i. Low water pressure cut-off: To protect pump in the event of low inlet pressure, manual reset with signal to BMS.
 - j. Low pressure discharge switch. To shut down the system if the pressure is not able to maintain 1,000 psi. Manual reset with signal to BMS.
 - k. Pump bypass to RO storage tank or finned tube heat exchanger for pump cooling during part load.
 - l. Low pressure gauge: liquid filled, for 0 to 100 psig.
 - m. High pressure gauge: liquid filled, for 0 to 2,000 psi.
 - n. Fitting and hoses: low-pressure side fittings shall be stainless steel construction. High-pressure side fittings shall be of 304 stainless steel. Low-pressure inlet hoses and high-pressure discharge hoses shall be provided as part of humidification system.
 - o. All wetted parts including piping shall be non-corrosive (stainless steel). Provide all necessary dielectric isolation.
3. Acceptable manufactures:
 - a. Go Fog
 - b. American Moistening Company (AMCO)
 - c. Dri-Steem

2.18 WATER TREATMENT

- A. Reverse osmosis (RO) water treatment system shall be provided as part of humidification system. The RO treated water shall be piped to the fog pump units for this central humidification system as part of this humidification work. Building water to be 50-74 degrees F at the inlet of the water treatment system. The RO system shall be controlled by an Allen Bradley MicroLogix 1400 control system for integration into the BMS system. RO system shall meet Division 25 Specifications and requirements of P&ID drawings. Provide 10-inch touchscreen interface to allow for status, set point control and alarm monitoring. Provide polyethylene storage tank. Provide guided wave radar continuous level probe in storage tank. Level probe shall be Keyence FL Series Liquid Level Sensor. Control system shall meet GPO standards for construction.
1. The system supplier shall conduct complete water analysis on the RO treated water and make recommendation for water treatment additionally required prior to commencing work.
 2. Water treatment system shall protect against:
 - a. Excessive plugging of nozzles, not more than 10 percent per year.
 - b. Any water condition that could cause excessive wear or damage to the fog nozzles.
 - c. Any dangerous bacteria growth or any condition that could result in dangerous bacteria growth, and any possibility of "dusting" of the air with mineral salts.
 - d. Droplet Filters and Frames: Filters shall be UL Class I rated; polymer based with biocide agent. Filters shall be rated for use up to 700 fpm. Filters shall be installed in a stainless-steel frame.
 3. Zone control valves:
 - a. High pressure motorized ball valves shall be provided on the water supply line to each humidification zone to stage the humidification process at the fog nozzles. The valves shall be rated for a minimum 6,000 psi operating pressure with stainless steel wetted parts.
 - b. Valve control panel to accept 4-20 mA demand signal from BMS.
 - c. Valve control panel to send a 24VDC pump enable during a demand for humidity.
 - d. Flush cycle to occur once every 24 hours for 30 seconds on each valve to keep fresh water in the system.
 - 1) Zone control valves are part of the water treatment system (Soft Water RO and high pressure pump skid) and requirements of P&ID drawings.

2.19 OUTDOOR SERVICE VESTIBULE

- A. Unit to be provided with an integral Service Vestibule. Access corridor to be minimum (8) ft. wide by full height and length of the unit. The access corridor shall be of the same construction as the unit previously described. Access corridor floor shall be level without obstructions such as at joining sections that might act as trip points.
- B. Provide a 5KW 3/60/460V electric unit heater with wall mounted thermostat for maintaining a minimum of 50 degrees F temperature during winter operation. Provide factory mounted and wired heater, disconnect switch and thermostat. Provide ventilation for removing heat of variable frequency drives and other devices within the vestibule by means of manually adjustable blast gates mounted in the side wall of the mixing box and supply air plenums.
- C. The service corridor shall provide for floor supporting of field piping installations. A pipe support structure shall be included as a means for pipe hangers to be attached to supporting members

with no fastening done to the AHU/corridor ceiling or walls. The support members shall be three feet on center and sized to support a uniform piping load of 250 lbs./ft. Pipe supports are to be provided by the AHU manufacturer and locations coordinated with the installing contractor.

2.20 ELECTRICAL

- A. Switches: Hubbell Model 1221W, CSA certified, 20 amps, 120-volt AC. Single pole Switch, self-grounding, side wire termination. Unless otherwise shown or specified, connect all air handling unit lighting fixtures to one switch. Junction box shall be "THOMAS & BETTS" universal FSU – 2 3/8 inches deep, cast aluminum and supplied with close-up plugs. Cover plate shall be plunger type with weatherproof enclosure.
- B. GFCI Receptacles: Hubbell GF20WL, duplex, CSA certified, heavy duty, white, 20 Amps, 125-volt AC. Two poles, 3 wires, flashing red LED signals loss of GFCI protection, steady on red LED signals ground fault condition. Back and side wire terminations accept up to #10 AWG wire. Provide (2) GFCI receptacles within service vestibule.
- C. 120-volt mini load centers: Square D "QO" NEMA 3R, 125A rating, part #QO124L125PGRB.
- D. Factory scope of work: The unit manufacturer shall furnish and wire a complete electrical system for the 120-volt load components. All 120-volt components shall be wired to terminate at a breaker panel / load center. Each circuit shall not exceed 20 amps. Provide multi-circuit breaker panels as required. Each air handling unit shall require a 480-volt power connection for each fan/motor system. Each motor shall include a non-fused, heavy duty rated, safety disconnect switch inside the fan section if physically possible, otherwise right outside the fan cabinet within the line of sight of the motor. The disconnect shall include an auxiliary contact to stop the frequency drive if the disconnect action is activated prior to stopping the variable frequency drive. The disconnect shall be ETL/UL listed.
- E. Wiring and Conduit: The unit wiring shall be stranded copper wire sheathed in a THHN covering, which shall be distributed through the unit in threaded rigid aluminum conduit; the use of aluminum wire or BX cable is prohibited. To allow for adjustment of fan motors, a 3'-0" section of weatherproof flex connect shall be provided at each motor. A separate ground wire for each motor shall be connected to a terminal in the disconnect switch. In addition to the requirements herein, wiring shall comply with NEC requirements for wash down duty (NEMA 4X). Inter-modular wiring shall terminate in a coiled configuration at the end of each module. The contractor shall pull the cables through the modules to complete the system wiring.
- F. Control Conduit: Provide one (1) 1-1/4-inch conduit raceways along the entire length of each unit with 12-inch X 12-inch X 8-inch stainless steel NEMA 4X junction boxes in each compartment section, to allow for routing of automatic temperature control wiring and tubing through the unit for outdoor units.

2.21 AHU CONTROL POINTS

- A. The following hardwired I/O points are the minimum required for each AHU. Refer to contract "CT" series documents for point listing. Network interfaces shall not be used for the items listed below. All control components, their installation, wiring and commissioning shall to be by the ATC contractor:

1. Analog (4 to 20 mA inputs to the PLC control system from the AHU:
 - a. Filter Differential Pressure (each back of filters – via differential pressure transmitter).
 - b. Outdoor Air Humidity.
 - c. Outdoor Air Temperature.
 - d. Outdoor Air Airflow Station.
 - e. Mixed Air Temperature.
 - f. Return Air CO2.
 - g. Return Airflow Station.
 - h. Return Air Humidity.
 - i. Return Air Temperature.
 - j. Supply Airflow Station.
 - k. Supply Air Humidity.
 - l. Supply Air Temperature. (Upstream of reheat coil).
 - m. Supply Air Temperature. (Downstream of reheat coil).
 - n. Supply Air Static Pressure Sensor.
 - o. Exhaust Air Damper Position
 - p. Mixed Air Damper Position
 - q. Return Air damper Position
 - r. Face Bypass Coil Damper Position
 - s. Chilled Water Control Valve Position
 - t. Preheat Coil Control Valve Position
 - u. Reheat Coil Control Valve Position
 - v. Chilled Water supply temperature
 - w. Chilled Water return temperature
 - x. Room Temperature Sensor(s).
 - y. Room Humidity Sensor(s)
2. Analog (4 to 20 mA) outputs from the PLC control system to the AHU:
 - a. Exhaust Air Damper
 - b. Mixed Air Damper
 - c. Outdoor Air Damper
 - d. Face Bypass Coil Damper
 - e. Chilled Water Coil Control Valve
 - f. Preheat Coil Control Valve
 - g. Reheat Hot Water Coil Control Valve
 - h. Humidifier Control Valve
 - i. Dehumidifier Command signal
3. Digital inputs to the PLC Control System the AHU:
 - a. Fire Alarm Return Air Smoke Detector (independent of supply duct detector and general fire alarm – coordinate with fire alarm contractor).
 - b. Fire Alarm Supply Air Smoke Detector (independent of return duct detector and general fire alarm – coordinate with fire alarm contractor).
 - c. Supply Air Fan VFD Auto Selector Switch
 - d. Supply Air Fan VFD Manual Selector Switch
 - e. Supply Air Fan Normal Selector Switch or Drive A Selected in an N+1 arrangement.
 - f. Supply Air Fan Bypass Selector Switch or Drive B Selected in an N+1 arrangement.
 - g. Supply Air Fan Contactors in Normal Position or Drive A Position in an N+1 Arrangement.

- h. Supply Air Fan Contactors in Bypass Position or Drive B Position in an N+1 Arrangement.
 - i. Supply Air Fan Start Push Button (Manual Mode Only).
 - j. Supply Air Fan Stop Push Button (Manual Mode Only).
 - k. Humidifier Run Status
 - l. Humidifier Fault/Alarm Status
- 4. Digital outputs from the PLC control system to the AHU:
 - a. Supply Air Fan in Auto Pilot Light
 - b. Supply Air Fan in Manual Pilot Light
 - c. Supply Air Fan Run pilot Light or Drive A Run in an N+1 Arrangement.
 - d. Supply Air Fan Drive Fault Pilot Light or Drive A Fault in an N+1 Arrangement.
 - e. Supply Air Fan in Bypass Mode Pilot Light or Drive B Run pilot light in an N+1 arrangement.
 - f. Supply Air Fan Bypass Fault Pilot Light or Drive B Fault Pilot Light in an N+1 Arrangement.
 - g. Humidifier Start Command.
 - h. Dehumidifier Start Command.
- 5. Network Interface to/from the AHU VFD's to the PLC control system:
 - a. Drive start Stop functions
 - b. Drive enable status.
 - c. Drive speed reference/ command.
 - d. Drive Faults
 - e. Drive amperage and KWh consumption.
 - f. Drive predictive maintenance functions (fan end of life IGBT end of life.)
 - g. Programmed maintenance functions based upon drive run times. (Lubrication schedules belt change schedules etc.)
 - h. Humidification pump control system PLC and drive status. Coordinate with owner on exact points).
 - i. RO System PLC and Drive Status. Coordinate with owner on exact points.

PART 3 EXECUTION

3.1 AIR HANDLING UNITS

- A. Mount on steel grillage as indicated.
- B. Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Mechanical Sound and Vibration Control."
- C. Construct field joints in accordance with manufacturer's recommendations. Provide continuous gaskets and caulk to assure air and water tightness.
- D. Check all seams and seals around coils and other components for leaks that may have developed in shipment and handling. Seal all leaks airtight in accordance with manufacturer's recommendations.

- E. Locate as indicated. Level unit.
- F. Provide electrical interconnection between unit and any remote-control panel in accordance with the electrical sections of this specification.
- G. Arrange installation of units to provide access around air handling units for service and maintenance.
- H. Do not operate fan system until filters (temporary or permanent) are in place/ Replace temporary filters used during construction and testing with new, clean filters.
- I. Connect duct to air handling units with flexible connections. Comply with requirements in Section 23 31 13 "Ducts & Ducts Accessories."
- J. Openings in panels where piping, drives, etc., pass through panels, provide sealed sleeves. Caulk annular space between service lines and sleeves.
- K. Lubricate bearings for extended shutdown or storage and rotate shafts every four weeks until fans are put into permanent operation. Verify lubrication for bearings and other moving parts prior to fan startup.
- L. Install air handling units with clearances for services and maintenance.
- M. Verify that shipping, blocking, and bracing are removed.
- N. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- O. With fan drive disconnected from wheel, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation after electrical wiring is connected to the motor.

END OF SECTION 23 73 23

SECTION 23 81 26 - SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Split-system air-conditioning units consisting of separate evaporator fan and compressor-condenser components.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 – General Requirements
- B. Section 23 05 00 – Basic Mechanical Materials and Methods
- C. Section 23 05 48 – Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification of Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 – Testing, Adjusting, and Balancing
- F. Section 23 08 13 – Commissioning of HVAC
- G. Section 23 20 00 – Building HVAC Services Piping
- H. Section 25 00 00 – Chiller Plant Control System
- I. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance: Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.
- D. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air handling units and components.
- E. AHRI Certification: Air handling units and their components shall be factory tested according to AHRI 430 and shall be listed and labeled by AHRI.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and Methods".
- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of component.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- E. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set for each air conditioning unit.

1.9 COORDINATION

- A. Coordinate sizes and locations of equipment supports and penetrations with actual equipment provided.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or re-

place components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period:

1. Warranty Period:
 - a. For Compressor: Two years from date of Substantial Completion.
 - b. For Parts: Two years from date of Substantial Completion.
 - c. For Labor: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 INDOOR UNITS

A. Wall-Mounted, Evaporator-Fan Components:

1. Drawing Designation: 04 02 SA FCU-3 and 4, 04 03 SA FCU-1 and 2.
2. Basis of Design: Daikin FTX series.
3. Cabinet: Enameled steel with removable panels on front and ends in color selected by Contracting Officer's Representative COR, and discharge drain pans with drain connection.
4. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with AHRI 206/110.
5. Fan: Direct drive, centrifugal:
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 00 "Basic Mechanical Materials and Methods."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. NEMA Premium efficient motors as defined in NEMA MG 1 or Electronically Commutated Motors.
 - d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - e. Mount unit-mounted disconnect switches on interior of unit.

1) Condensate Drain Pans:

- a) Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and to direct water toward drain connection:
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 1-inch deep.
 - c. Provide Condensate Pump
- b) Single-wall, galvanized-steel sheet.
- c) Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan:

- a. Minimum Connection Size: 1-1/4-inch.
- 2) Pan-Top Surface Coating: Asphaltic waterproofing compound.
- 3) Air Filtration Section:
 - a) General Requirements for Air Filtration Section:
 - a. Comply with NFPA 90A.
 - b. Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.
 - b) Disposable Panel Filters:
 - a. Factory-fabricated, viscous-coated, flat-panel type.
 - b. Thickness: 1-inch.
 - c. Minimum MERV according to ASHRAE 52.2: 5.
 - d. Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
 - e. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.2 OUTDOOR UNITS

A. Air-Cooled, Compressor-Condenser Components:

- 1. Drawing designation: 04 10 SA CND-1, 2, 3 and 4.
- 2. Basis of Design: Daikin RX series to match indoor unit.
- 3. Casing: Steel, finished with baked enamel in color selected by COR, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 4. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor:
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with AHRI 206/110.
- 5. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
- 6. Fan: Aluminum-propeller type, directly connected to motor.
- 7. Motor: Permanently lubricated, with integral thermal-overload protection.
- 8. Low Ambient Kit: Permit operation down to 0 degrees F.
- 9. Mounting Base: Polyethylene.

2.3 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 25 00 00 "Chiller Plant Control System."
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
- D. Drain Hose: For condensate.
- E. Monitoring:
 - 1. Monitor constant and variable motor loads.
 - 2. Monitor variable frequency drive operation.
 - 3. Monitor cooling load.
 - 4. Monitor air distribution static pressure and ventilation air volumes.

2.4 MANUFACTURERS

- A. Daikin, LG, Mitsubishi.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on equipment rails specified in Section 23 20 00 Building HVAC Services Piping." Anchor units to supports with removable, cadmium-plated fasteners.
- D. Equipment Mounting: Comply with requirements for vibration isolation devices specified in Section 23 05 48 "Mechanical Sound and Vibration Controls."
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service:
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

- A. Train Government's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26

SECTION 23 82 39 - UNIT HEATERS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Unit Heaters with hot water heating coils and associated integral supports, accessories, piping, fans, motors, and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 20 00 - Building HVAC Services Piping
- G. Section 23 21 16 – Hydronic Piping Specialties
- H. Section 23 21 23 – Hydronic Pumps
- I. Section 23 25 13 – Water Treatment Systems
- J. Section 23 25 33 – HVAC Water Filtration Equipment
- K. Section Up flow 25 00 10 Hot Water Skid Control System
- L. Division 26 - Electrical

1.3 QUALITY ASSURANCE

- A. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by local authority and is equivalent in safety to UL labeled equipment.
- B. Comply with AHRI 440.
- C. Comply with UL 2021.

1.4 ACTION SUBMITTALS

- A. Submit in accordance with Division 01 and Section 23 05 00, "Basic Mechanical Materials and

Methods”.

- B. Manufacturer's technical product data, including installation instructions, performance data, accessories, supports, fittings, finishes, construction details, and dimensions of components:
 - 1. Propeller Unit Heaters.
 - 2. Cabinet Unit Heaters.
- C. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- D. Include details of anchorages and attachments to structure and to supported equipment.
- E. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
- F. Wiring Diagrams: Power, signal, and control wiring.
- G. Color samples for selection by Contracting Officer's Representative (COR) for cabinet unit heaters.
- H. Manufacturer's sound power levels for motorized equipment.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide emergency, operation, and maintenance manuals for unit heaters.

1.6 APPLICABLE PUBLICATIONS

- A. The publications form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation.

1.7 PROJECT CONDITIONS

- A. Provide all material and equipment specified in this section with performance requirements as stated herein or on the drawings.
- B. Except where specified, equipment and system capacities and performance requirements are scheduled on the drawings.

PART 2 PRODUCTS

2.1 GENERAL

- A. Capacities as indicated on the drawings.

2.2 PROPELLER UNIT HEATERS

- A. Drawing Designation: 04 03 HW UH-1, 2, 3, 4, 5, 6, and 7.
- B. Propeller type horizontal discharge equivalent to Trane Model S with double deflection vanes for vertical and horizontal directional air control, fan guard.
- C. Housings:
 - 1. Finish: Manufacturer's standard baked enamel applied to factory-assembled and tested propeller unit heaters before shipping.
 - 2. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- D. Coils:
 - 1. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
 - 2. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 degrees F, with manual air vent. Test for leaks to 350 psig underwater.
- E. Fan and Motor:
 - 1. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
 - 2. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 23 05 00 "Basic Mechanical Materials and Methods."
 - 3. Provide disconnect switch.

2.3 CABINET UNIT HEATERS

- A. Drawing Designation: 04 03 HW UH-8, and 9, 04 03 ELEC UH-1,2,and 3.
- B. Coil Section Insulation:
 - 1. Insulation Material: Mineral fiber insulation with aluminum foil facing to prevent erosion of glass fibers or flexible elastomeric.
 - 2. Thickness: Manufacturer's standard but not less than 1/2 inch.
 - 3. Thermal Conductivity (k-Value): Minimum 0.24 Btu x in./h x sq. ft. at 75 degrees F mean temperature.
 - 4. Fire-Hazard Classification: Maximum flame spread index of 25 and smoke developed index of 50.
 - 5. Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- C. Cabinet Type:
 - 1. Vertical cabinet type equivalent to Trane Force-Flo Model.
 - 2. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by COR.

3. Vertical Unit, Exposed Front Panels: 16 gage galvanized steel front panel, 18 gage all other panels, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 4. Recessed Flanges: Steel, finished to match cabinet.
 5. Tamper proof Control Access Door: Key operated.
 6. Extended Piping Compartment: 8-inch-wide piping end pocket.
 7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.
- D. Filters: 1-inch throwaway type.
- E. Coils:
1. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins and rated for a minimum working pressure of 200 psig and a maximum entering water temperature of 220 degrees F. Include manual air vent and drain.
 2. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, mounted in ceramic inserts in galvanized steel housing; with fuses in terminal box for overcurrent protection and limit controls for high temperature protection. Terminate elements in stainless steel machine staked terminals secured with stainless steel hardware.
 - a. Factory equip electric heaters with 120 volt prewired controls including heater switch, magnetic contactors UL listed for 100,000 cycles, fan override thermostat, dead front switch, motor and control transformer, and terminals for space thermostat connection./
- F. Fan and Motor Board: Removable:
1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Motor: Single-speed motor permanently lubricated, resiliently mounted on motor board.
 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 4. Provide factory mounted disconnect switch.
- G. Cabinet Style:
1. Surface Mounted: Upflow
 2. Top: Sloped.
 3. Air Inlet: Front, punched louver.
 4. Air Outlet: Front punched louver.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install and wire unit heaters in accordance with manufacturer's recommendations and applicable national and local Code. Coordinate with Electrical Contractor.
- B. Install unit heaters to comply with NFPA 90A.
- C. Install unit heaters level and plumb.
- D. Suspend propeller unit heaters from structure with all-thread hanger rods and vibration isolators specified in Section 23 05 48 "Mechanical Sound, and Vibration Controls".
- E. Secure cabinet unit heaters to wall.

3.3 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.
- B. Comply with safety requirements in UL 1995.
- C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 23 82 39

SECTION 23 82 19 - FAN COIL UNITS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Fan Coils with hot water coils, accessories, piping, fans, motors, and integral controls.

1.2 RELATED DIVISIONS AND SECTIONS

- A. Division 01 - General Requirements
- B. Section 23 05 00 - Basic Mechanical Materials and Methods
- C. Section 23 05 48 - Mechanical Sound and Vibration Controls
- D. Section 23 05 53 – Identification for Mechanical Piping, Ductwork, and Equipment
- E. Section 23 05 93 - Testing, Adjusting, and Balancing
- F. Section 23 20 00 - Building HVAC Services Piping
- G. Section 23 21 16 – Hydronic Piping Specialties
- H. Division 26 - Electrical

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- C. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
- B. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
- C. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Fan Coil Unit Filters: Furnish 1 spare filters for each filter installed.

1.7 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Factory-packaged and -tested units rated according to AHRI 440.

2.2 DUCTLESS FAN COIL UNITS

- A. Drawing Designation: 04 02 SA FCU-1 and 2.
- B. Manufacturers:
 - 1. Multi Aqua
 - 2. Or approved equal.
- C. Fan Coil Unit Configurations: Row split.
- D. Number of Heating Coils: One with two-pipe system.
- E. Coil Section Insulation: 1/2-inch- (13-mm-) thick, foil-covered, closed-cell foam complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
- F. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum

flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- H. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."
- I. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
- J. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- K. Drain Pans: Plastic. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- L. Cabinet: Composed of high impact polymers. Composed of
- M. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
- N. Washable Foam: 70 percent arrestance and MERV 3.
- O. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 150 psig (1378 kPa) and a maximum entering-water temperature of 160 deg F (104 deg C). Include manual air vent and drain valve.
- P. Fan and Motor Board: Removable.
- Q. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
- R. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- S. Wiring Termination: Connect motor to chassis wiring with plug connection.
- T. Basic Unit Controls:
 - 1. Control voltage transformer.
 - 2. Wall-mounting thermostat with the following features:
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
- U. Electrical Connection: Factory wire motors and controls for a single electrical connection.
- V. Capacities and Characteristics:

1. As scheduled on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
- D. Connect condensate drain to indirect waste.
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- C. Perform the following tests and inspections:
- D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
- E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

SECTION 25 00 00 - CHILLER PLANT CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Section includes the general requirements for the Integrated Automation systems. Integrated Automation Systems are utilized on Production equipment and systems, chiller and boiler plants, scrap processing and dust collection systems, electrical substations, HVAC equipment, pollution control equipment, air, water (domestic hot and chilled), steam and natural gas systems.

1.2 RELATED DIVISIONS AND SECTIONS

1. All project sections within Division 01 – General Requirements
 2. Section 22 05 00 - Basic Plumbing Materials and Methods
 3. Section 22 05 53 - Identification for Plumbing Piping and Equipment
 4. Section 23 05 00 - Basic Mechanical Materials and Methods
 5. Section 23 05 53 - Identification for Mechanical Piping Ductwork and Equipment
 6. Section 23 21 16 - Hydronic Piping Specialties
 7. Section 23 21 23 - Hydronic Pumps
 8. Section 23 25 23 – HVAC Water Filtration Equipment
 9. Section 23 57 00 – Heat Exchangers
 10. Section 23 64 16 - Liquid Water Chillers
 11. Section 23 65 13 - Packaged Cooling Towers
 12. All project sections within Division 25 – Integrated Automation
 13. All project sections within Division 26 – Electrical
- B. Where architectural features govern location of work, refer to architectural drawings and coordinate with other trades.

1.3 REFERENCES

- A. This section includes any rules and regulations of Federal, State, local authorities, and utility companies in force at the time of execution of contract.
- B. Agencies or publications referenced herein refer to the following:
1. ADA: Americans with Disabilities Act
 2. ANSI: American National Standards Institute
 3. ASHRAE: American Society for Heating, Refrigeration, Air-Conditioning Engineers
 4. ASTM: American Society for Testing and Materials
 5. BICSI: Building Industry Consulting Services International
 6. EIA: Electronic Industries Association
 7. FCC: Federal Communications Commission
 8. ICEA: Insulated Cable Engineers Association
 9. IEEE: Institute of Electrical & Electronics Engineers
 10. ISO: International Organization for Standards
 11. NEC: National Electrical Code (2020)
 12. NECA: National Electrical Contractors Association

- 13. NEMA: National Electrical Manufacturers Association
- 14. NETA: National Electrical Testing Association
- 15. NIST: National Institute of Standards & Technology
- 16. OSHA: Occupational Safety and Health Administration
- 17. TIA: Telecommunications Industries Association
- 18. UL: Underwriters Laboratories, Inc.

1.4 DEFINITIONS

- A. AHU: Air Handling Unit.
- B. ATC: Automatic Temperature Control.
- C. ATU: Air terminal Unit.
- D. AWG: American Wire Gauge (standard wire size measurement)
- E. BAS/BMS: Building Automation System/Building Management System.
- F. Device: Intelligent controller or other automated monitoring piece of equipment.
- G. CD: Compact Disc used for data storage.
- H. Commissioning: Process to ensure installation and functionality is per design.
- I. Enterprise: Top level of integrated systems for overall logistical monitoring and business planning.
- J. EMS: Enterprise Management System.
- K. FCU: Fan Coil Unit.
- L. PLC: Programmable Logic Controller.
- M. I/O: Hardware inputs and outputs.
- N. Instrument: Device used to sense inputs or control outputs or both.
- O. Integration: Connection of disparate systems to a common platform using communication protocols.
- P. IP Address: Internet Protocol node address
- Q. IT: Information Technologies.
- R. O&M: Operation & Maintenance Manuals.
- S. Object: Hardware or Software component such as a device or point.
- T. Point: Single hardware input/output or software data objects such as set points and attributes.

- U. Point list: List of inputs, outputs and parameters for specific systems.
- V. RFI: Request for Interpretation.
- W. Stand-Alone: the ability to function upon loss of communication.

1.5 SYSTEM DESCRIPTION

- A. The chiller plant control system includes integration, control and monitoring of the various chilled water production systems the facility including:
 - 1. Chillers including integration to PLC control system.
 - 2. Cooling towers and condenser water pumps.
 - 3. Chilled water pumps.
 - 4. All instrumentation and accessory hardware shown on the P&ID drawings.
 - 5. All variable frequency drives and control panels as shown on the P&ID drawings.
 - 6. All PLC hardware and control panels as detailed in the specifications.
 - 7. All electrically operated valves as shown on the P&ID drawings.
 - 8. All modulating control valves as shown in the P&ID drawings.
 - 9. Local operator interface terminals required for local control and monitoring.
 - 10. All other instrumentation shown on the P&ID drawings.

1.6 CONTRACTOR REQUIREMENTS

- A. Chiller Plant control system includes but is not limited to labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, network termination to GPO supplied network hardware, integration equipment, instrumentation and controls and integrated automated systems. The contractor is required to provide the following:
 - 1. Procurement and installation of integrated automated systems hardware.
 - 2. Procurement and installation of automation systems SCADA software if specified in other sections.
 - 3. Integration of equipment systems with the automation systems SCADA software. This includes equipment supplied by others as shown in contract drawings.
 - 4. Procurement of ancillary equipment installed by others. This includes but is not limited to: labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, instrumentation and controls and integrated automated systems.
 - 5. Controls contractor is required to furnish and install the following, and is responsible for the equipment and software as shown below as well as the contract documents:
 - a. PLC control cabinets completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.
 - b. VFD control panels completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.
 - c. Field mounted line or load reactors or harmonic filters for VFD's.

- d. All control valves and actuators with position feedback Valves shown in the specs and on the contract drawings. Valves installed by piping contractor.
- e. All temperature and humidity sensors shown in the specs and on the contract drawings. Provide all mounting accessories and thermowells for pipe mounting of temperature transmitters and humidity sensors.
- f. All magnetic flowmeters. Installed by piping contractor.
- g. Differential pressure transmitters. To be installed by piping contractor.
- h. Pressure transmitters as specified or as shown on contract drawings. Provide block and bleed valves for all pressure transmitters.
- i. Continuous level transmitters for each tower basin for level control.
- j. Any PLC and VFD panel supplemental air conditioners that may be shipped loose and field installed by the contractor.
- k. Computer equipment mounted in control panels as shown on contract drawings, or as specified in other sections.
- l. SCADA software as shown on contract drawings or as specified in other sections.
- m. Computer Servers and workstations as shown on the contract drawings or as specified in other sections.
- n. UPS systems as shown on the contract drawings.
- o. Any owner supplied equipment as specified in the contract documents.
- p. All Ethernet cabling from GPO supplied network equipment. Contractor will coordinate with owner on cable labeling requirements.

1.7 SUBMITTALS

- A. Contractor is to submit a complete schedule of submissions before submittal process.
- B. Submit each section independent and separate from other sections. For each product submission: contractor is to provide specification section and product number.
- C. Include only products within referenced specification section submission.
- D. Product Data: For each product submission, include the following:
 - 1. Table of contents for each submission.
 - 2. Submit each section independent and separate from other sections. Include only products within referenced specification section submission.
 - 3. Product data sheets for all required components and accessories.
 - 4. Submit manufactures checklist & calibration documentation for calibrated instrumentation.
 - 5. Identify actual product model number used for each drawing.
 - 6. Identify any proposed modifications to system design. (Specifications or Drawings)
 - 7. Organize product data based on specification Section, Part, and Article.
 - 8. A paragraph-by-paragraph specification compliance report indicating compliance for each numbered paragraph. The following format shall be used in completing the compliance report:
 - a. Comply—without exception.
 - b. Qualify—meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.
 - c. Does not comply—cannot meet specified function.

- E. Integration Plan: Network architecture and communications concepts/diagrams. Network architecture includes but is not limited to:
1. Nodes.
 2. Switches, include GPO furnished network hardware.
 3. Integrated systems and/or sub-systems.
 4. Dedicated I/O locations.
 5. Non-Ethernet communications cabling.
 6. Coordination submission. Include an integration matrix detailing systems and protocols to be used. This includes equipment such as chiller, RO water systems, boilers and humidification systems.
 7. Workflow processes to integrate systems
 8. Include communication hardware (gateways), software, and protocols to implement full systems integration.
 9. Identify proposed enhancements or deviations from project documents. Include specific drawings or specifications impacted.
 10. Provide coordination efforts to accommodate complete integration of systems including:
 11. Vendor protocol requirements.
 12. Vendor point list.
 13. Submit PLC ladder logic for review.
 14. Submit maintenance schedules for all controller, valves, dampers, and instrumentation.
 15. Complete set of control and wiring diagrams. Include panel layout drawings if not shown on contract drawings.
- F. Start-up Plan:
1. Provide complete start up plan.
 2. Coordination of equipment controlled and monitored.
 3. Workflow process to start equipment.
 4. Equipment start-up requirements.
 5. Checklist.
 6. Intended sequence of work items.
 7. Start dates of individual work items.
 8. Duration of individual work items.
 9. Planned delivery dates for major material and equipment, and expected lead times.
 10. Milestones indicating possible restraints on work by other trades or situations.
 11. Coordinate equipment startup to coincide with construction schedules.
 12. Provide multiple startup and commissioning trips at no additional cost to owner to allow for phased startup of the mechanical systems.
- G. Owner Instruction and Training Plan:
1. Provide 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.

h. Recommended classroom training and schedule.

H. Record Documents:

1. Include field condition updates.
2. Document material, make and model numbers where appropriate.
3. Update details, schedules, risers, etc.
4. I/O point as-built drawings.
5. Sequence details, modifications, or updates.
6. Control loops including final set-points and parameters.
7. Mark and detail on coordination drawings, exact locations of equipment installed.
8. Panel details for each unique panel.
9. PLC program backups.
10. Operator interface screen program backups.
11. SCADA application program backups.
12. All passwords and security configuration for all hardware and software.
13. All configuration and programming software for all controls as specified by owner and contract documents.

I. O&M Manuals:

1. O&M manuals for all equipment supplied under this contract. Include complete parts lists and bill of materials for PLC control panels and VFD panels.
2. At minimum, submit two electronic copies and four hard copies.
3. Do not include previously submitted product data.
4. Include a table of contents.
5. Tab manual based on specification chapters or sections.
6. Network architecture and communications concepts/diagrams.
7. Uploading and downloading software to the field hardware.
8. Finely detailed descriptions of all software programs.
9. Complete set of software engineering manuals.
10. Complete system design and engineering manual same as used by manufactures personnel.
11. Application Programming.
12. CD of any configuration tools used in project.
13. Operator instructions or User Manual.
14. Calibration and/or verification sheets for all instrumentation including but not limited to:
 - a. Liquid Flow Meters.
 - b. Air or gas Flow Meters.
 - c. CO2 Sensors.
 - d. Temperature Sensors.
 - e. Humidity Sensors.
 - f. Pressure transmitters.
 - g. Differential pressure transmitters.
 - h. Airflow monitoring stations.

J. Project Maintenance Manuals:

1. Include a table of contents.
2. 1 copy on CD three hard copies.
3. Organize by manual by specification section number.

4. Index sheet listing contents in alphabetical order.
5. Include the following:
 - a. Installation instructions.
 - b. Manufacturer's operating and maintenance instructions (not product submittals).
 - c. Factory and field-test records, including calibration and factory setup.
 - d. Printout of application control programs, one electronic copy and 2 hard copies.
 - e. Snapshot printout of each system installed.
 - f. Signed checklist of each system showing complete I/O checkout and system commissioning.
 - g. Training schedule and course description catalog.
 - h. Archived backup of software, drawings, and record documents.
 - i. Installation contractor and service representative information.
 - j. Licensing and warranty information including provided software.
 - k. Documentation verifying all software licenses have been transferred to GPO.

K. Submit a User Workstation Planning Session Plan for each subject:

1. Graphics Generation.
2. Tag naming.
3. Alarm management.
4. Report Configuration.

1.8 QUALITY ASSURANCE

- A. All systems, equipment, components, accessories, and installation hardware must be new, free from defects, and currently in production.
- B. All work shall be compliant with applicable national and local codes.
- C. Demonstrate project compliance to Engineers satisfaction including construction and integration.
- D. Provide the same manufacturer components of a given type product throughout project.
- E. Support future compatibility for no less than 15 years with the ability to upgrade existing field panels and extend new field panels on an installed network.
- F. Digital equipment furnished under this contract shall have been tested and made to comply with limits of Class A computing device pursuant to Subpart J of Part 15 of FCC Rules.
- G. Maintain NEC workspace clearances:
 1. Install and operationally check systems utilizing factory-trained competent technicians skilled in the setting and adjustment of equipment used in this project.
- H. Test, adjust, and calibrate all end instruments before startup and commissioning.
- I. Follow project communication protocol for all correspondence. Any changes, decisions, etc. must be properly documented. The Engineer will not issue verbal directions. Verbal interpretations, clarifications, conversations, etc. are non-binding without proper documentation.

- J. Request for Interpretation (RFI) shall include:
1. Referenced drawing and/or Specification Section number.
 2. Single request per RFI.
 3. Single proposed solution per RFI.
 4. Attached sketch of solution (if applicable).
 5. Attached specification verbiage (if applicable).
 6. Incomplete RFI's will be returned without response.
 7. Contact person.
- K. RFI answers are for clarification only and do not authorize additional work or change orders.
- L. Install devices in appropriate enclosure and in an accessible location.
- M. Install systems and devices in a neat, workmanlike manner and in accordance with manufacturer's recommendations.
- N. Continually monitor the field installation for code compliance and quality workmanship.
- O. Remove and re-install any systems or devices where installation is deemed of poor quality by Owner or Engineer.
- P. Provide software and firmware updates prior to and within 2 months of substantial completion.
- Q. Lead the coordination effort to ensure integration of various systems prior to installation.
- R. Comply with all health and safety regulations.
- S. Include automatic restart logic for loss of power, safeties, fire alarm shutdown, etc.
- T. Provide components not specifically indicated or specified, but necessary to make system function within the intent of contract documents.
- U. All electrical products to be listed and labeled by UL and comply with NEMA Standards.
- V. Provide a competent and experienced Project Manager.
- W. Engineering services shall be performed by factory-trained engineers.
- X. System shall be installed by factory trained mechanical and electrical installers either in direct employ of this Contractor or by subcontractors who are under direct supervision of this Contractor.
- Y. Use only manufacturer trained technicians who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided under this section.
- Z. Coordinate with the Owner to ensure that the control system will perform on the Owner's network environment without disruption to any of the other activities taking place on that LAN.

PART 2 PRODUCTS

2.1 GENERAL CONTROL PRODUCTS

- A. GPO has standardized on Allen Bradley Controls as the basis for all building monitoring and production control systems. GPO has standardized on Inductive Automation Ignition software for HMI Visualization and monitoring software. GPO has invested significant capital in training, software and support agreements; therefore, the use of alternate equipment and software is not permitted.
- B. All control systems shall be based upon the Allen Bradley Control Logix platform. This includes all equipment and systems detailed in section 1.4.
- C. Allen Bradley Control hardware:
 - 1. The processors shall be Control Logix 5580 series processors.
 - 2. Provide a minimum of 2 spare slots in each rack or 20% spare rack space for each I/O rack.
 - 3. Provide 1756-PA75 series power supplies for common spare parts inventory.
 - 4. Analog input modules shall be 1756-IF16. Modules shall be configured for single ended current mode. Provide 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 5. Analog output modules shall be 1756-OF8. Module shall be configured for current output mode. 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 6. Digital input modules shall be 1756-IA16 or 1756-IB16. Provide 1492-IFM20 interface module and pre wired factory assembled cable.
 - 7. Digital output modules shall be 1756-OA16. Provide 1492-XIM20120-16R Relay interface module and pre-wired factory assembled cable.
 - 8. Provide din rail mounted signal conditioners to provide isolation for analog inputs from field devices that are powered from separate DC supply.
 - 9. 24VDC DC power supplies shall be equivalent to Allen Bradley 1606-XL240E. Power supply shall have a mean time between failure (MTBF) of 1,058,000 hours at 24VDC and 10 amps (full load). All power supplies shall be UL listed. Substitute power supplies shall be shall only be provided with the GPO approval during shop drawing review.
 - 10. Miniature circuit breakers shall be one, two or three pole design. UL 489 listed:
 - a. Dual rated for AC or DC applications.
 - b. DIN rail mounted miniature circuit breakers up to 63-amp current rating.
 - c. Current limiting design to provide fast short circuit interruption. that reduces the
 - d. Suitable for reverse feed applications
 - e. Suitable for branch circuit device
 - f. Fulfills UL 489, CSA C22.2 No.5 as well as IEC 60947-2 Standards.
 - g. Thermal-magnetic overcurrent protection
 - h. Three levels of short circuit protection, categorized by B, C and D curves.
 - i. SWD (switching duty) rated circuit protection.
 - j. Size breakers and trip curve in accordance with UL 508A.
 - k. Circuit breakers are not allowed on motor loads with the exception of electrically operated valves. All other motor loads will be protected with class J fuses.
 - 11. Terminal blocks shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated at a minimum of 30 amps at 600 Volts and shall accommodate wire sizes of 24 to 10 AWG.

12. Terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 volt and shall accommodate wire sizes of 14 to 1/0 AWG.
13. Grounding terminal blocks shall be green/ yellow in color din rail mountable and UL listed. Grounding terminal blocks shall be rated at a minimum of 35 amps at 600 volts and shall accommodate wire sizes of 26 to 10 AWG.
14. Grounding terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 Volts and shall accommodate wire sizes of 14 to 1/0 AWG.
15. All terminal blocks shall have a short circuit rating of no less than 100KA per UL 508A.
16. Terminal blocks and other panel components shall be mounted on din rail. Din rail shall be 1.38" x .30". Zinc-Plated Clear Chromated Steel and be UL listed.
17. I/O interface modules shall be mounted on elevated din rail. Elevated din rail shall be Symmetrical Rail 1.38" x .30" 2.26". high 3.28' long Copper-Free Aluminum and UL listed.
18. Push Buttons shall be 30 mm Allen Bradley 800H- series. No substitutions. Provide 2 NC –NO contact blocks for each operator. Button colors shall be green for start motor applications, red extended head for motor stop applications and black for general control functions. Provide other colors as determined by owner.
19. Selector switches shall be 1.18" Allen Bradley 800H series with standard operators. No substitutions Provide 1 NC-NO contact for each position.
20. Pilot lights shall be 1.18" Allen Bradley 800H series full voltage (12 to 130 Volt AC/DC) LED indicators. No substitutions. Provide color coded lenses for the following functions. Red indicates fault condition, Green indicates run or normal condition, blue indicates automatic mode, amber indicates manual or bypass mode. Provide color coded lenses as shown on contract drawings.
21. Provide all push buttons, selector switches and pilot lights with engraved legend plates. Plates shall be 2.25" x 2.25" square "automotive style" White with black letters. Legend plates shall be suitable for outdoor use. Emergency stop legend plates shall be yellow with black letters.

PART 3 EXECUTION INSTALLATION AND COMMISSIONING

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Store products according to manufacturer's recommendations.
- B. Store products in original manufacturers packaging.
- C. All material shall be stored in a climate-controlled environment.
- D. Do not store products more than 3 months prior to schedule installation.
- E. Coordinate deliveries of material with construction schedule and appropriate trades.

3.2 SCHEDULING

- A. Included in this project are connections to equipment provided by others. Coordinate deliveries, final locations, factory mounting, and various connections required.

- B. Coordinate activities with contract project schedule:
 - 1. Ensure integration activities are incorporated into project schedule.
 - 2. Communicate requirements to prevent potential damage from paint, dust, water, weather, etc.
 - 3. Monitor and take measures to assure protection for all equipment.
- C. Coordinate all IT requirements with owner and contract project schedule.

3.3 WARRANTY

- A. Submit warranty documentation upon completion of project or phase and acceptance by Engineer and Owner.
 - 1. Warranty start date shall be the date of substantial completion.
 - 2. Warranty period shall be 1 year on parts and labor and include 2 years of software upgrades.
- B. Repair or replace systems or parts found defective at no cost to Owner including: but not limited to:
 - 1. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period.
 - 2. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
 - 3. Include parts, labor, and necessary travel during warranty.
- C. Scheduled preventive maintenance (p.m.) visit twice a year during the warranty period to audit system performance.
 - 1. Each p.m. visit shall include exercising each control loop and control sequence for performance.
 - 2. A log of each loop tested and each control sequence verified shall be reviewed with the Owner.
- D. Provide vendor specific warranty information.
- E. Provide services incidental to proper performance.

3.4 SYSTEM STARTUP

- A. Start equipment according to manufactures recommendation.
- B. Document system start up time and date.
- C. Document person(s) performing startup.
- D. Coordinate startup with other trades.

- E. All equipment installation is to be complete before startup.

3.5 OWNER'S INSTRUCTIONS

- A. Provide a factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of each piece of equipment or system. Instructors shall be thoroughly familiar with all aspects of the subject matter.
- B. The training shall be specifically oriented to the system and interfacing equipment installed.
- C. Include classroom instruction and field demonstration:
- D. Classroom instruction should include at a minimum:
 - 1. Detailed review of and as-built documentation and conditions
 - 2. In depth discussion of theory or sequence of operations
 - 3. Review organization and usability of O&M documentation
 - 4. Maintenance procedures and schedules
- E. Field instruction should include at a minimum
 - 1. Normal maintenance procedures
 - 2. Demonstration of operation
 - 3. Demonstration of safeties and interlocks

3.6 COMMISSIONING

- A. Participate in the commissioning process.
- B. Provide on-site programming support throughout the commissioning process to make program modifications as directed by the commissioning engineer.
- C. Provide documentation in final O&M package that reflects any changes made during the commissioning process.
- D. Provide necessary personnel during the commissioning process to test and validate all field devices and PLC I/O.
- E. Provide on-site start up support for each phase of equipment startup as well as final system commissioning.

END OF SECTION - 25 00 00 – CHILLER PLANT CONTROL SYSTEM

25 00 00 10 - LOCAL OPERATOR INTERFACE TOUCH SCREENS

PART 1 GENERAL

1.1 SUMMARY

- A. Each PLC cabinet shall be equipped with a local Operator interface screen (HMI).
- B. Coordinate screen development with owner. Follow owners design standards for interface screens.

1.2 REFERENCES

- A. National Fire Protection Association - NFPA 70 - US National Electrical Code.
- B. National Electrical Manufacturers Association - NEMA 250 - Enclosures for Electrical Equipment.
- C. Underwriters Laboratory Inc. – UL 508.
- D. International Electrical Code - IEC 146.
- E. Institute of Electrical and Electronics Engineers, Inc. - IEEE 519 - IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 33 00
- B. Shop Drawings – Approval.
- C. Data Sheet and installation instructions.
- D. HMI Screens application programs.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Allen Bradley PanelView Plus. Catalog number 2711P-T10C21D8S.
- B. Allen Bradley PanelView 5000. Catalog number 2713P -T10CD1.
- C. Allen Bradley PanelView 5000. Catalog number 2715P-T10CD.
- D. Maple Systems Advanced HMI series. Catalog number HMI5150XL

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 00 10 LOCAL OPERATOR INTERFACE TOUCH SCREENS

25 00 00 20 - VARIABLE-FREQUENCY MOTOR CONTROLLER

PART 1 GENERAL

1.1 SUMMARY

- A. The Variable Frequency Drive (VFD) system shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.
- B. The Variable Frequency Drive systems shall be provided by the controls contractor.

1.2 REFERENCES

- A. National Fire Protection Association - NFPA 70 - US National Electrical Code.
- B. National Electrical Manufacturers Association - NEMA 250 - Enclosures for Electrical Equipment.
- C. Underwriters Laboratory Inc. – UL 508.
- D. Canadian Standards Association International – CAN/CSA-C22.2 No. 14-05.
- E. International Electrical Code - IEC 146.
- F. Institute of Electrical and Electronics Engineers, Inc. - IEEE 519 - IEEE Standard Practices and Requirements for Harmonic Control in Electrical Power Systems.

1.3 SUBMITTALS

- A. Submit under provisions of Section 01 33 00
- B. Shop Drawings – Approval:
 - 1. Elevation Drawings: Include dimensional information and conduit routing locations.
 - 2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
- C. Wiring Diagrams:
 - 1. Power Diagram: Include amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings, etc. as required for approval.
 - 2. Control Diagram: Include disconnect devices, pilot devices, etc.
 - 3. Major components list.
- D. Product Data Sheets:
 - 1. VFD and Operator Interface publications.

2. Data sheets and publications on all major components including but not limited to the following:
 - a. Contactors.
 - b. Fuses (power and control).
 - c. Control power transformers.
 - d. Pilot devices.
 - e. Relays/Timers.
 - f. Test procedures shall be per the manufacturer's standards.

1.4 CLOSEOUT SUBMITTALS (OPERATION AND MAINTENANCE MANUALS)

- A. Submit under provisions of Section 01 33 00.
- B. Shop Drawings – Final as shipped:
 1. Elevation Drawings: Include dimensional information and conduit routing locations.
 2. Unit Descriptions: Include amperage ratings, enclosure ratings, fault ratings, nameplate information, etc. as required for approval.
 3. Wiring Diagrams:
 4. Power Diagram: Include amperage ratings, power fuses continuous amp ratings, etc. as required for approval.
 5. Control Diagram: Include disconnect devices, pilot devices, etc.
 6. Major components list.
- C. Product Data Sheets:
 1. VFD and Operator Interface publications.
- D. Data sheets and publications on all major components including but not limited to the following:
 1. Contactors.
 2. Fuses (power and control).
 3. Control power transformers.
 4. Pilot devices.
 5. Relays/Timers.
- E. Test procedures shall be per the manufacturer's standards.
- F. Operation and Maintenance Data:
 1. Service and Contact information.
 2. VFD and Operator Interface User Manuals.
 3. Troubleshooting / Service Manuals.

1.5 QUALITY ASSURANCE

- A. Qualifications:

1. Manufacturers: Allen Bradley PowerFlex 755. No substitutions.
2. The VFD and all associated optional equipment shall be UL listed or recognized.
3. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system and must be registered to ISO 9001 and regularly reviewed and audited by a third-party registrar.
4. The VFD shall be pre-wired, assembled and tested as a complete package.
5. The VFD shall be sided for heavy duty service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
- B. Contractor shall store the equipment in a clean and dry space at an ambient temperature range of -40 °F to 158 °F.
- C. The contractor shall protect the units from dirt, water, construction debris and traffic.

1.7 WARRANTY

- A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.
- B. This warranty applies to variable-frequency drive systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Allen-Bradley® – PowerFlex® 755 VFD (No substitutions)

2.2 2.2 VARIABLE FREQUENCY DRIVE UNIT

- A. Features:
 1. Certifications.
 2. Listed to UL508C and CAN/CSA-C22.2 No. 14-05
 3. In conformity with EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC). Standards applied; EN 61800-3:2004, EN 61800-5-1:2007.
 4. TÜV Rheinland - standards applied: EN 61800-3:2004, EN 61800-5-1:2007, EN ISO 13849-1:2008, EN ISO 13849-2:2003, EN 61800-5-2:2007, EN 61508 PARTS 1-7:2000, EN 62061:2005, and EN 60204-1:2006.
 5. Australian Communications and Media Authority. In conformity with Radio communications Act: 1992, Radio communications Standard: 2008, and Radio communications Labeling Notice: 2008. Standards applied: EN 61800-3:2004.
 6. Electric Power Research Institute. Certified compliant with standards SEMI F47 and IEC 61000-4-34.

7. Russian GOST-R Certificate No. POCC US.ME92.H00040.
8. American Bureau of Shipping (ABS) Certificate 11-HS743429-PDA.
9. Lloyd's Register Type Approval certificate 11/60008.
10. RINA Certificate ELE349811CS.

B. Hardware:

1. Utilize diode bridge or SCR bridge on the input rectifier.
2. Utilize DC bus inductor on all six-pulse VFD's only.
3. Utilize switching logic power supply operating from the DC bus.
4. Incorporate phase to phase and phase to ground MOV protection on the AC input line.
5. Utilize gold plated plug-in connections on printed circuit boards.
6. Microprocessor-based inverter logic shall be isolated from power circuits.
7. Utilize latest generation IGBT inverter section.
8. Inverter section shall not require commutation capacitors.
9. Embedded Ethernet port for direct network cable connections.
10. Battery receptacle for Lithium battery power to the Real Time Clock.
11. Additional DPI port for handheld and remote HIM options.
12. Dedicated Digital Input for hardware enable.
13. Conformal coated printed circuit boards.
14. Optional onboard 24V DC Auxiliary Control Power Supply when required.

C. Control Logic:

1. Ability to operate with motor disconnected.
2. Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
3. Provide multiple programmable stop modes including Ramp, Coast, DC-Brake, Ramp-to-Hold, Fast Braking, and Current Limit Stop.
4. Provide multiple acceleration and deceleration rates.
5. Adjustable output frequency up to 590 Hz.

D. DeviceLogix™ Control:

1. Ability to control outputs and manage status information locally within the VFD.
2. Ability to function stand-alone or complimentary to supervisory control.
3. Ability to speed reaction time by processing in the VFD.
4. Ability to provide scaling, selector switches, or other data manipulations not already built into the VFD.
5. Ability to read inputs/write outputs and exclusively control the VFD.
6. Ability to provide an option for decision making if communication is lost with main controller.
7. Ability to control other VFD's via a peer-to-peer EtherNet/IP network.
8. Ability to write programs off-line.

E. Motor Control Modes:

1. Selectable Sensorless Vector, Flux Vector, V/Hz, Interior Permanent Magnet Motor, Surface Mount Permanent Magnet Motor, and Adjustable Voltage Control modes selectable through programming.
2. The drive shall be supplied with a Start-up and Auto-tune mode.
3. The V/Hz mode shall be programmable for fan curve or full custom patterns.

4. Capable of Open Loop V/Hz.
- F. Current Limit:
1. Programmable current limit from 20% to 160% of rated output current.
 2. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
 3. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.
- G. Acceleration / Deceleration:
1. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
 2. A second set of remotely selectable accel/decel settings shall be accessible through digital inputs.
- H. Speed Profiles:
1. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S Curve" profiles that provide changing accel/decel rates.
 2. S Curve profiles shall be adjustable.
- I. Adjustments:
1. A digital interface can be used for all set-up, operation and adjustment settings.
 2. All adjustments shall be stored in nonvolatile memory.
 3. No potentiometer adjustments shall be required.
 4. Nonvolatile memory for factory default values shall be provided.
 5. Software must be available for trending and diagnostics, as well as online and offline programming functionality.
- J. Process PID Control:
1. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
 2. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the set-point, the regulator shall adjust the drive output until the feedback equals the reference.
 3. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
 4. Protection shall be provided for a loss of feedback or reference signal.
- K. Skip Frequencies:
1. Three adjustable set points that lock out continuous operation at frequencies, which may produce mechanical resonance shall be provided.
 2. The set points shall have a bandwidth adjustable from Maximum Reverse Speed to Maximum Forward Speed.
- L. Fault Reset / Run:

1. When the drive is running or idle, it shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
2. The automatic mode shall not be applicable to shorted output faults and other internal microprocessor faults.
3. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.

M. Run on Power Up:

1. A user programmable restart function shall be provided to allow restart of the equipment after restoration of power after long duration power outages. Restart time dependent on presence of incoming signal.

N. Fault Memory:

1. The last 32 fault codes shall be stored and time stamped in a fault buffer.
2. Information about the drive's condition at the time of the last fault such as operating frequency, output current, DC bus voltage and twenty-seven other status conditions shall be stored.
3. A power-up marker shall be provided at each power-up time to aid in analyzing fault data.
4. The last 32 alarm codes shall be stored and time stamped for additional troubleshooting reference.

O. Overload Protection:

1. The drive shall provide internal class 10 adjustable overload protection.
2. Overload protection shall be speed-sensitive and adjustable.
3. A viewable parameter shall store the overload usage.

P. Auto Economizer:

1. An auto economizer feature shall be available to automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage.
2. When the load increases, the drive shall automatically return to normal operation.

Q. Terminal Blocks:

1. For frames 1 to 7, a separate terminal block shall be provided for power wiring.
2. For frames 8-10, power wiring is landed on robust L-brackets behind the drive unit. This wiring remains in-place if the drive unit is removed.
3. Terminal blocks shall be provided for control wiring on all frames
4. I/O terminal blocks shall be removable with wiring in place.

R. Flying Start:

1. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. This feature should be enabled during startup.

S. Inputs and Outputs:

1. The Input / Output option modules shall consist of both analog and digital I/O.
2. No jumpers or switches shall be required to configure digital inputs and outputs.
3. All digital input and output functions shall be fully programmable.
4. The control terminal blocks shall be rated for 600V AC.
5. Inputs shall be optically isolated from the drive control logic.
6. The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.
7. The VFD shall be capable of supporting up to 10 analog inputs, 10 analog outputs, 31 digital inputs, 10 relay outputs, 10 transistor outputs, and 5 positive temperature coefficient (PTC) inputs.
8. The Input / Output option modules shall have the following features:
 - a. Analog Inputs: Where specified.
 - b. Quantity one (1) or two (2) differentially isolated, $\pm 10V$ (bi-polar), 88k ohm input impedance, 11 bit plus sign.
 - c. Analog inputs shall be user programmable for a variety of uses including frequency command and process loop input. Analog inputs shall be user programmable for function scaling (including invert), offset, signal loss detect and square root.
 - d. Analog Outputs: Where specified.
 - e. Quantity one (1) or two (2) $\pm 10V$ (bi-polar) / 11 bit & sign, 2 k Ω minimum load, 4-20 mA, 11 bit plus sign, 400 Ω maximum load.
 - f. The analog output shall be user programmable to be proportional to one of fourteen process parameters including output frequency, output current, encoder feedback, output power.
 - g. Programming shall be available to select either absolute or signed values of these parameters.
 - h. Digital Inputs: Where specified.
 - i. Quantity three (3) or six (6) digital inputs rated 24VDC DC/115V AC.
 - j. All inputs shall be individually programmable for multiple functions including: Start, Run, Stop, Auxiliary Fault, Speed Select, Jog and Process PI functions.
 - k. A single safety input (ATEX) shall be a configurable option for a thermostat or PTC temperature sensor.
 - l. Digital Outputs: Where specified.
 - m. At a minimum one (1) relay output (N.O. or N.C.).
 - n. For 240V AC or 24V DC, N.O. contact output ratings shall be 2-amp max., general purpose (inductive)/resistive. N.C. contact output ratings shall be 2-amp max., resistive only.
 - o. Relays shall be programmable to multiple conditions including: Fault, Alarm, At Speed, Drive Ready and PI Excess Error.
 - p. Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.
 - q. Transistor outputs are available in quantities varying from zero (0) to two (2).
 - r. For 24V DC, transistor output rating shall be 1 amp max, Resistive.

T. Reference Signals:

1. The drive shall be capable of using the following input reference signals:
 - a. Analog inputs.
 - b. Preset speeds.
 - c. Remote potentiometer.
 - d. Digital MOP.

- e. Human Interface Module.
- f. Communication networks.

U. Loss of Reference:

1. The drive shall be capable of sensing reference loss conditions.
2. In the event of loss of the reference signal, the drive shall be user programmable to the following:
 - a. Fault the drive and coast to stop.
 - b. Issue a minor fault - allows the drive to continue running while some types of faults are present.
 - c. Alarm and maintain last reference.
3. When using a communications network to control the drive, the communications adapter shall have these configurable responses to network disruptions and controller idle (fault or program) conditions:
 - a. Fault.
 - b. Stop.
 - c. Zero Data.
 - d. Hold Last State.
 - e. Send Fault Configuration.
4. Coordinate with GPO to determine the proper configuration for each application.

V. Metering:

1. At a minimum, the following parameters shall be accessible through the Human Interface Module:
 - a. Output Current in Amps.
 - b. Output Voltage in Volts.
 - c. Output Power in Kw.
 - d. Elapsed MWh.
 - e. DC Bus Voltage.
 - f. Frequency.
 - g. Heatsink Temperature.
 - h. Last eight (32) faults.
 - i. Elapsed Run Time.
 - j. IGBT Temperature.

W. Faults:

1. At a minimum, the following faults shall be accessible through the Human Interface Module:
 - a. Power Loss.
 - b. Undervoltage.
 - c. Overvoltage.
 - d. Motor Overload.
 - e. Heatsink Over-temperature.
 - f. Maximum Retries.

g. Phase to Phase and Phase to Ground Faults.

X. Predictive Diagnostics:

1. At a minimum, the following predictive diagnostic features shall be provided:

- a. Relay Output Life Cycles based on load type and Amps.
- b. Hours of Fan Life based on load and ambient temperature.
- c. Motor Bearing life based on expected hours of use.
- d. Motor Lubrication schedule based on hours of use.
- e. Machine bearing life based on expected hours of use.

Y. Real-Time Clock:

- 1. Shall be capable of providing time stamped events.
- 2. Shall have the ability to be set locally or via a remote controller.
- 3. Shall provide the ability to be programmable for month, day, year and local time zones in HH:MM:SS.

Z. Programmable Logic Controller Integration:

- 1. The drive shall have the following specific features to enable integration with a Rockwell Automation® ControlLogix® Automation Controller.
- 2. Shall have an Add-on Profile available for use with Rockwell Automation Studio 5000® programming software.
- 3. Shall support Rockwell Automation controller's Automatic Device Configuration functionality.

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 00 20 VARIABLE-FREQUENCY MOTOR CONTROLLER

25 00 00 30 - VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. The Variable Frequency Drive (VFD) system shall contain all components required to meet the performance, protection, safety and certification criteria of this specification.
- B. All Variable frequency Drives shall be Allen Bradley PowerFlex 755.
- C. The Variable Frequency Drive systems shall be provided by the controls contractor.
- D. Features:
 - 1. Ratings: The drive and all components shall have a SCCR rating of 100KIA.
 - 2. Voltage: Capable of accepting nominal plant power of 400V, 480V, 600V or 690V AC at 50 Hz or 60 Hz. The supply input voltage tolerance shall be $\pm 10\%$ of nominal line voltage.
- E. Displacement Power Factor:
 - 1. Six-pulse VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of 0.95 or better at rated load and nominal line voltage, over the entire speed range.
- F. Efficiency:
 - 1. A minimum of 96.5% (+/- 1%) at 100% speed and 100% motor load at nominal line voltage.
 - 2. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.
 - 3. Operating ambient temperature range without derating: 32 °F to 104 °F
 - 4. Operating relative humidity range shall be 5% to 95% non-condensing.
 - 5. Operating elevation shall be up to 3,300 ft without derating.
- G. Sizing:
 - 1. Drive selections shall be sized for Heavy-Duty loads.
 - 2. Drives shall provide 150% overload capability for up to one minute and 180% for up to 3 seconds.
- H. Auto Reset/Run:
 - 1. For faults other than those caused by a loss of power or any other non-critical fault, the drive system shall provide a means to automatically clear the fault and resume operation.
- I. Ride-Through:
 - 1. The VFD system shall attempt to ride through power dips up to 20% of nominal. The duration of ride-through shall be inversely proportional to load. For outages greater than

20%, the drive shall stop the motor and issue a power loss alarm signal to a process controller, which may be forwarded to an external alarm signaling device.

J. Run on Power Up

1. The VFD system shall provide circuitry to allow for remote restart of equipment after a power outage. Unless indicated in the contact drawings, faults due to power outages shall be remotely resettable. The VFD system shall indicate a loss of power to a process controller, which may be forwarded to an external alarm signaling device. Upon indication of power restoration, the process controller will attempt to clear any faults and issue a run command, if desired.

K. Communications:

1. VFD shall provide an embedded EtherNet/IP port.
2. VFD shall be capable of communicating on multiple networks.
3. VFD shall be capable of supporting the following network options as detailed in the specifications and drawings:
 - a. DeviceNet.
 - b. EtherNet/IP.
 - c. ControlNet Coax.
 - d. ControlNet Fiber.
 - e. Interbus.
 - f. CANopen.
 - g. Modbus/TCP.
 - h. Modbus RTU.
 - i. Profibus DP.
 - j. RS-485 DF1.
 - k. RS-485 HVAC.
 - l. Remote I/O.
 - m. Profinet I/O.
 - n. BACnet/IP.

L. Enclosure Door Mounted Human Interface Module (HIM):

1. An enclosure door-mounted HIM, rated NEMA/UL Type 1 or NEMA/UL Type 4/12, shall be provided for each VFD and Soft Start mounted in the drive enclosure.
2. The HIM shall have the following features:
 - a. A three (3) line by twenty-one (21) character backlit LCD display with graphics capability.
 - b. Shall indicate drive operating conditions, adjustments and fault indications.
 - c. Shall be configured to display in the following three distinct zones:
 - d. The top zone shall display the status of direction, drive condition, fault / alarm conditions and Auto / Manual mode.
 - e. The middle zone shall display drive output frequency.
 - f. The bottom zone shall be configurable as a display for either programming menus / information or as a two-line user display for two additional values utilizing scaled units.
 - g. Shall provide digital speed control.

- h. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.

M. Enclosure:

1. Shall be rated NEMA/UL Type (12).
2. Exterior drive cabinets shall be NEMA 4X stainless steel.
3. Shall be painted per the manufacturer's standard.
4. Shall provide entry and exit locations for power cables.
5. The drive system nameplate shall be marked with system Short Circuit Current Rating (SCCR) and additional information to meet NFPA 70 409.110(4) 2018 Edition.
6. Provide closed loop air conditioner for each drive cabinet.
7. Air conditioner shall have a hermetically sealed compressor and utilize R-134 refrigerant.
8. Air conditioner shall be equipped with Active Condensate System using PTC heater element.
9. Air conditioner shall be equipped with washable, reusable 8-layer aluminum mesh filters.
10. Air conditioners shall be equipped with Digital Touchpad Programmable Controller, viewable and accessible from inside enclosure.
11. Air-conditioner shall be warranted for a period of 2 years.
12. Provide thermoelectric heater/ coolers for drive cabinets located outdoors. Thermoelectric cooler shall be NEMA 4X Stainless construction.
13. As an alternate, provide water cooled heat exchanger for VFD cabinets feeding air handlers or areas where chilled water is available. Run insulated chilled water supply and return piping to heat exchanger. Provide factory installed thermostat, water solenoid valve and alarm contact wired to PLC input. Heat exchanger to be Kooltronic KPHE Series Water-to-Air Panel-Mounted Heat Exchangers.

N. Drive Enclosure Input Disconnect:

1. Provide an enclosure flange mounted interlocked disconnect with class J fusing. Door mounted disconnects are not permitted.
2. Provide externally operated main disconnect handle. Handle rating shall match the enclosure rating. Provide Steel disconnect handles for interior locations. Provide stainless steel disconnect handles for stainless steel enclosures.
3. Handles shall be lockable.

O. Branch Circuit Protection:

1. Class J Input fusing shall be provided for each VFD and bypass mounted within the VFD enclosure.
2. Utilize finger safe fuse holders with blown fuse indicators for all fuses.
3. 2 pole fuse holders for transformers shall be equivalent to Ferraz US3J2I 2-Pole 30A Class J UltraSafe Fuse Holder.
4. 30 Amp fuse holders shall be equivalent to Ferraz US3J3I 3-Pole 30A Class J UltraSafe Fuse Holder.
5. 60 Amp fuse holders shall be equivalent to Ferraz US3J6I 3-Pole 60A Class J UltraSafe Fuse Holder.
6. 100 Amp fuse holders shall be equivalent to Ferraz 61008SJ Provide finger safe covers with blown fuse indicators.
7. Provide 3 spare fuses for each size utilized on a drive cabinet.

P. Non bypass operation:

1. Provide the following door mounted controls for non-bypass drive enclosures:
 - a. Hand/ Off/ Auto Selector Switch for each motor.
 - b. Start Stop push buttons for each motor while in manual mode.
 - c. Pilot lights to indicate Automatic, Manual, Run and Fault indications.
- Q. Manual Bypass Option: when specified:
1. Shall provide a means to manually switch a single motor from drive control to bypass (across the line operation below 10 Hp or SMC Flex soft start 10 HP and above.)
 2. Shall provide separate drive input, drive output and bypass output contactors. The contactors shall be electrically and mechanically interlocked.
 3. Shall provide Hand/ Off/ Auto Selector Switch for each motor.
 4. Shall provide Start Stop push buttons for each motor while in manual mode.
 5. Shall provide a Drive/Off/Bypass selector switch, as well as drive and bypass status pilot lights mounted on the enclosure door, for selection of Drive and Bypass modes of operation as well as drive and bypass indication pilot lights.
 6. Shall provide pilot lights to indicate Automatic, Manual, Run and Fault indications.
 7. Shall provide separate input fusing for drive and bypass.
 8. Provide a Class 10 overload for motor protection while operating in the bypass mode.
- R. Select components in accordance with:
<http://raise.rockwellautomation.com/raconfig/rtcache/pdf/SCCR-44651M.pdf> to ensure proper SCCR ratings.
1. VFD control panel shall be rated for 100,000 KIAC.
- S. Automatic Bypass Option: when specified:
1. Shall provide a means to automatically (upon a drive fault) switch a single motor from drive control to bypass (across the line operation).
 2. Shall provide separate drive input, drive output and bypass contactors. The contactors shall be electrically and mechanically interlocked.
 3. Shall provide Hand/ Off/ Auto Selector Switch for each motor.
 4. Shall provide Start Stop push buttons for each motor while in manual mode.
 5. Shall provide a Drive/Bypass selector switch, drive and bypass status pilot lights mounted on the enclosure door, for selection of Drive and Bypass modes of operation as well as drive and bypass status.
 6. Shall provide a Drive/Off/Bypass selector switch, and drive status pilot lights mounted on the enclosure door, for selection of Drive and Bypass modes of operation as well as drive status.
 7. Shall provide pilot lights to indicate Automatic, Manual, Run and Fault indications.
 8. Provide a Class 10 overload for motor protection while operating in the bypass mode.
- T. Select components in accordance with:
<http://raise.rockwellautomation.com/raconfig/rtcache/pdf/SCCR-44651M.pdf> to ensure proper SCCR ratings.
1. VFD control panel shall be rated for 100,000 KIAC.
- U. SMC 50 Bypass: when specified:

1. Shall provide a means to manually or automatically switch a single motor from drive control to bypass via a soft start (across the line operation). Soft start must be Allen Bradley SMC-50 on order to meet SCCR ratings
 2. Shall provide separate drive input, drive output, bypass input and bypass output contactors. The contactors shall be electrically and mechanically interlocked.
 3. Shall provide Hand/ Off/ Auto Selector Switch for each motor.
 4. Shall provide Start Stop push buttons for each motor while in manual mode.
 5. Shall provide a Drive/Off/Bypass selector switch, and drive status pilot lights mounted on the enclosure door, for selection of Drive and Bypass modes of operation as well as drive status.
 6. Shall provide pilot lights to indicate Automatic, Manual, Run and Fault indications.
 7. Provide a Class 20/30 overload for motor protection while operating in the bypass mode.
 8. Shall provide smooth deceleration when stopping in bypass mode.
 9. Shall provide a door-mounted HIM for soft start and drive for each motor.
 10. Shall provide separate bypass fusing.
- V. Select components in accordance with:
<http://raise.rockwellautomation.com/raconfig/rtcache/pdf/SCCR-44651M.pdf> to ensure proper SCCR ratings.
1. VFD control panel shall be rated for 100,000 KIAC.
 2. Provide SMC 50 with Ethernet I/P network interface card.
- W. N+ 1 Drive option: when specified:
1. Shall provide a manually controlled means to switch a single motor from primary drive to secondary drive.
 2. Shall provide separate drive input, drive output contactors for each drive. The contactors shall be electrically and mechanically interlocked.
 3. Shall provide Hand/ Off/ Auto Selector Switch for each motor.
 4. Shall provide Start Stop push buttons for each motor while in manual mode.
 5. Shall provide a Drive 1 Drive 2 selector switch, and drive status pilot lights mounted on the enclosure door, for selection of Drive 1 and Drive 2 modes of operation as well as drive status.
 6. Shall provide a door-mounted HIM for each motor and drive.
 7. Shall provide separate drive fusing for each drive.
- X. Select components in accordance with:
<http://raise.rockwellautomation.com/raconfig/rtcache/pdf/SCCR-44651M.pdf> to ensure proper SCCR ratings.
1. VFD control panel shall be rated for 100,000 KIAC.
- Y. Provide the following door mounted controls for each motor:
1. Provide a "Hand/Off/Auto" selector switch, for each motor, mounted on the enclosure door.
 2. The "Hand/Off/Auto" selector switch shall start the drive in the "Hand" mode and stop the drive in the "Off" mode.
 3. In the "Auto" mode, the drive shall be started and stopped from the PLC network interface.
 4. In the event of a network or PLC failure, the Drive can be started from the door mounted HIM.

5. In all modes, Auxiliary and Enable inputs to the drive control interface board must be present before the drive will start.
6. Provide a door mounted HIM for each drive.
7. When a HIM is present, the stop function shall always be available to stop the drive regardless of the selected mode ("Hand" or "Auto"). The HIM will be non-functional (except for the display and programming) when the switch is in "Off" mode. The HIM shall stop the drive if the switch is in the "Auto" mode with the remote start signal initiated.
8. The drive speed reference shall be controlled from the network interface form the PLC.
9. The drive shall have the capability of smoothly transferring from the automatic speed reference to the manual speed reference on the HIM, without perturbation in the speed reference.
10. The drive speed reference shall be controlled by the PLC speed reference.
11. Provide Start Stop push buttons for each motor.
12. 1Provide selector switches for specified bypass modes.

Z. Control Power Transformer:

1. Provide a control power transformer mounted and wired inside of the drive system enclosure.
2. The transformer shall be rated for the VFD control power and air conditioning requirements.
3. Protect the control transformer primary side with Class J fuses per UL 508A. Protect all ungrounded secondary side of control transformer with UL 489 rated branch circuit protection device.

AA. Harmonic Mitigation Techniques:

1. Drive Input Line Reactor where specified.
2. Provide a drive input line reactor mounted within the drive system enclosure for drives that are less than 100 horsepower.
3. The line reactor shall meet the following specifications:
 - a. The construction shall be iron core with an impedance of 3 percent.
 - b. The winding shall be copper.
 - c. The insulation shall be Class H with a 115 °C rise over 50 °C ambient.
 - d. The unit shall be rated for system voltage, ampacity, and frequency.
 - e. Passive Harmonic Filter where specified.
 - f. Provide a passive harmonic filter for line side of drive mounted in drive enclosure.
 - g. Harmonic filter must meet the IEEE-519 requirements for harmonic distortion, regardless of power load.
 - h. Harmonic filter shall be MTE Corporation Matrix AP series or equal.
 - i. Harmonic filter shall be rated for system voltage, ampacity and frequency.
 - j. Harmonic filter ampacity shall be sized for full load amperage of drive or 125% of motor full load.

BB. Motor Protection Techniques:

1. Drive Output Line Reactor where specified.
2. Provide a drive output line reactor mounted within the drive system enclosure for drives that are less than 100 horsepower:
3. The output reactor shall meet the following specifications:
 - a. The construction shall be iron core with an impedance of 3 percent.

- b. The winding shall be copper.
 - c. The insulation shall be Class H with a 115 °C rise over 50 °C ambient.
 - d. The unit shall be rated for system voltage, ampacity, and frequency.
 - e. dV/dt filter where specified, and on motor leads greater than 50 feet.
 - f. Inverter Operating Frequency 0 – 90Hz without derating
 - g. Operating temperature: -40°C to +60°C modular filter, -40°C to +50°C enclosed filter.
 - h. Common Mode Reduction: Insertion Loss (Voltage) 1.7% @ 60Hz; 2.6% @ 90Hz
 - i. Efficiency: >99%
 - j. Altitude Without Derating: 3,300 feet above sea level.
 - k. Maximum Motor Lead Length: 1,000 feet.
 - l. Peak Rise Protection: 50%+ peak current reduction typical.
 - m. dV/dt filter shall be MTE Corporation dV Sentry.
4. For motors 100 HP and above, utilize Allen Bradley PowerFlex 755T Series drives.

END OF PART - 25 00 00 30 VARIABLE FREQUENCY DRIVE SYSTEMS

25 00 00 40 - FIELD EQUIPMENT CONTROL PANELS

PART 1 GENERAL

1.1 SUMMARY

- A. Control panel requirements for chiller plant control system.

1.2 REFERENCES

- A. ANSI 61 Drinking Water System Components - Health Effects.
- B. NEMA 1 General Purpose - for use in dry indoor locations. Allowed for junction boxes only.
- C. NEMA 12 Primarily for industrial indoor use. Protection against dust, falling dirt, fibers and lint. Protection from dripping water and other noncorrosive liquids Resistant to damage from external condensation of noncorrosive liquids. Required in all mechanical and production areas.
- D. NEMA 4X Watertight – Stainless Steel for use in locations where subjected to direct water spray and hose down environments. Required on chemical feed equipment, cooling towers, steam hot water sets and all locations outdoors.

1.3 DEFINITIONS

- A. Rung – Logical decision resembling the rung of a ladder within a ladder logic diagram.
- B. Wiring Duct –Pathway for wire management inside of panels.
- C. Wiring Trough – Wiring enclosure used to manage wiring outside of panels.
- D. Refer to section integrated automation for additional definitions.

1.4 SYSTEM DESCRIPTION

- A. Field equipment panels include, but not limited to control panels for:
 - 1. Air Handler systems.
 - 2. Chiller systems.
 - 3. Boiler systems.
 - 4. Exhaust Fan systems.
 - 5. Pumping Systems.
 - 6. Miscellaneous systems.
 - 7. Building Monitoring systems.
 - 8. Production equipment.
 - 9. Conveying equipment related to production and scrap handling systems.

- B. Enclosures for all controllers and instruments except those furnished by equipment manufacturers for factory mounted controls.

1.5 SUBMITTALS

- A. Submit control panel fabrication drawings including: back-panel layout, panel face arrangement, panel name, and panel tag number (if applicable) prior to fabrication or device installation.
 - 1. Drawings must show operator interface devices (touch screen, push buttons, pilot lights, drive and soft start HIM on panel face and device locations on back (sub) panel.
 - 2. Include panel tagging schedule or identification detailing nameplate text and size.
 - 3. Include panel power schematic showing power sources and protection device capacity.
 - 4. List manufacturer supplied devices in bill of material table.
 - 5. Submit schematic and wiring interconnection drawings in ladder format.
 - 6. Include rung numbers. Number relays with rung number.
 - 7. Control wiring and device numbers shall use the following nomenclature: XX-YYY where XX corresponds to the page number and YYY is the line number. Increment line wire numbers as they pass through devices.
 - 8. Each relay function shall be fully described to right of relay right rung. Each relay contact location shall be referenced at coil location.
 - 9. Each contact shall have associated coil reference and shortened description of coil function. Each contact shall have relay pin-out identifiers.
 - 10. Wire colors and designators shall be identified.
 - 11. Terminal blocks shall be uniquely identified. Field and panel wiring shall be differentiated by solid line for panel and dashed line for field.
 - 12. Each connection to field device or other remote panel shall be identified.

1.6 QUALITY ASSURANCE

- A. Enclosures shall be free of scratches, dents, overspray, oil, etc. at substantial completion. Thoroughly clean interior and exterior of all panels.
- B. Include instrument/equipment tag numbers, when available, on submittal documents whenever specific component appears.
- C. Install panels according to manufacturer's instructions.
- D. Space wire-ways and terminal strips 3" apart.
- E. Locate terminal strips either horizontally in upper half of back panel or vertically. Do not locate terminal strips below 2'-0" or above 6'-6" above finished floor.
- F. Separate 24 VDC and 120 VAC terminal strips, wire, cable, and devices by 6" minimum space.
- G. Provide terminal strips for total controller I/O count plus 20% spare capacity with analog and discrete spare capacity calculated separately. Provide DIN rail space for all Spare I/O interface modules.
- H. Size wire-way to maximum fill of 40% per NEC.

- I. Space controllers according to manufacturer's requirements with 3" minimum between controllers and other devices on back panel and 6" between controller front and door mounted devices. Ensure adequate space is allowed for device heat dissipation.
- J. Control enclosure interior temperature to 80°F maximum. Provide supplemental air conditioning if control panel internal temperature exceeds 80°F.
- K. Do not place any devices on enclosure sides. This includes wire way, terminal strips, and relays.
- L. Provide 25% minimum spare capacity of panel space, spare controller chassis space, wiring duct space, and terminal blocks to allow for future expansion by adding I/O cards and associated cabling.
- M. Locate panels adjacent to equipment served with minimum of 3 ft clearance in front of door. Provide sufficient clearances to allow full door swing and full access to internal components. Remote mounted panels are acceptable where accessibility will be significantly improved.
- N. Mount top of panels between 5 and 6 ft. above floor so that gauges and indicators are at eye level.
- O. Route and terminate exposed door mounted device wiring parallel and at right angles within panels. Utilize spiral wrap duct to protect exposed wiring.
- P. All wiring within control panel shall be routed within wire-ways.
- Q. Terminate power within 4 inches of panel entrance.
- R. Refer to Integrated Automation for additional requirements.
- S. Control Panels are to be manufactured to UL 508A standards. GPO may request that control panels be inspected and labeled for an additional fee from the panel fabricator. The intent being the design, quality and workmanship of the control panel be sufficient to pass a field UL inspection without additional modification. Should any control panel fail to meet UL 508 standards, any modification costs and reinspection fees will be the contractor's responsibility.

PART 2 PRODUCTS

2.1 ENCLOSURES

- A. Manufacturer: Hoffman, Saginaw Control and Engineering or approved equal.
- B. Construction:
 - 1. Minimum 14-gauge steel.
 - 2. Hinged door.
 - 3. Include inner panel.
 - 4. ANSI 61 external powder paint finish.
 - 5. Cylinder locks and master 4 master keys for all panels less than 8 foot above finished floor.
 - 6. Include print pockets on enclosure doors.

7. Miscellaneous steel components, e.g., standoffs, shall be 12-gauge minimum rolled steel.
8. All disconnect enclosures shall be flange mounted type. Through the door disconnects are prohibited.
9. All drive cabinet disconnects shall utilize class J fusing. Size motor load fusing per NEC and drive manufactures data.

C. Floor Mounted Panels:

1. Minimum size for panel fastening anchors shall be 9/16".
2. Unless otherwise specified, install floor mounted control panel(s) on four 4" concrete equipment pad(s) with grout as required.
3. Install two (2) anchors for each four (4) feet of equipment length or minimum of four (4) anchors. Decrease anchor spacing for heavy panels as required. Bolt equipment to pad using cap screws and washers.

D. Wall Mounted Panels:

1. Minimum size for wall fastening anchors shall be 3/8".
2. Provide one anchor for every 4'-0" of outside perimeter for wall mounted panels; minimum anchors for wall mounted panels shall be 4. Decrease anchor spacing for heavy panels as required.
3. Provide clear space for dressing out wiring, cables and tubing entering panel. Provide 4"2 unrestricted clear space for each inch of conduit size or each square inch of wiring duct size, with 4" x 4" being minimum area, in alignment with entering conduit or wiring duct, for bringing wiring into panel and routing to other locations.

2.2 WIRING DUCT

A. Manufacturers: Panduit, Tyton, IB0CO or approved alternate.

B. Construction:

1. Slotted plastic or vinyl (PVC)
2. Color: White
3. Snap-on covers

2.3 WIRING TROUGH

A. Manufacturer: Hoffman, Hammond Manufacturing or approved equal.

B. Construction:

1. Minimum 14-gauge steel.
2. NEMA 12 Construction.
3. Screw cover or hinged cover.

2.4 AC POWER SUPPLIES

A. Transformers for use with air flow monitoring stations only:

1. Input Power: 120 VAC to 480 VAC
2. Output Power: 24 VAC
3. Minimum capacity 100 VA
4. Resettable Circuit Breaker.
5. External Plug.
6. Functional Devices PSH100A100A Series.

2.5 UNINTERRUPTABLE POWER SUPPLY

A. UPS for use with digital controllers where specified:

1. Input Power: 120 VAC
2. Output Power: 120V VAC
3. Minimum capacity 1000 VA
4. Resettable Circuit Breaker
5. Battery Failure Notification
6. Audible Alarm
7. APC SUA500PDR-S

2.6 MINIATURE CIRCUIT BREAKERS

A. Miniature circuit breakers shall be one, two or three pole design. UL 489 listed:

1. Dual rated for AC or DC applications.
2. DIN rail mounted miniature circuit breakers up to 63-amp current rating.
3. Current limiting design to provide fast short circuit interruption.
4. Suitable for reverse feed applications.
5. Suitable for branch circuit device.
6. Fulfills UL 489, CSA C22.2 No.5 as well as IEC 60947-2 Standards.
7. Thermal-magnetic overcurrent protection
8. Three levels of short circuit protection, categorized by B, C and D curves.
9. SWD (switching duty) rated circuit protection.
10. Size breakers and trip curve in accordance with UL 508A.
11. Utilize factory buss bar components for breakers that are grouped together.

2.7 TERMINAL BLOCKS

- A. Terminal blocks shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated at a minimum of 30 amps at 600 Volts and shall accommodate wire sizes of 24 to 10 AWG.
- B. Terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 volt and shall accommodate wire sizes of 14 to 1/0 AWG.

- C. Grounding terminal blocks shall be green/ yellow in color din rail mountable and UL listed. Grounding terminal blocks shall be rated at a minimum of 35 amps at 600 volts and shall accommodate wire sizes of 26 to 10 AWG.
- D. Grounding terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 volt and shall accommodate wire sizes of 14 to 1/0 AWG.
- E. All terminal blocks shall have a short circuit rating of no less than 100KA per UL 508A.
- F. Terminal blocks and other panel components shall be mounted on din rail. Din rail shall be 1.37" x 3" Zinc-Plated Clear Chromated Steel and be UL listed.
- G. I/O interface modules shall be mounted on elevated din rail. Elevated din rail shall be Symmetrical Rail 1.37" x 3" 2.26 in. high 3.28 ft. long Copper-Free Aluminum and UL listed.

2.8 PUSH BUTTONS SELECTOR SWITCHES AND PILOT LIGHTS

- A. Push buttons and pilot lights shall be 1.18" Allen Bradley 800H- series. No substitutions.
 - 1. Provide 2 NC –NO contact blocks for each operator. Button colors shall be green for start motor applications, red extended head for motor stop applications and black for general control functions. Provide other colors as determined by owner.
 - 2. Selector switches shall be 1.18" Allen Bradley 800H series with standard operators. No substitutions. Provide 1 NC-NO contact for each position.
 - 3. Pilot lights shall be 1.18" Allen Bradley 800H series full voltage (12 to 130 Volt AC/DC) LED indicators. No substitutions. Provide color coded lenses for the following functions. Red indicates fault condition, Green indicates run or normal condition, blue indicates automatic mode, amber indicates manual or bypass mode. Provide additional color-coded lenses as shown on contract drawings.
 - 4. Push buttons shall be 1.18" Allen Bradley 800H series. No substitutions. Provide 2 NC- NO contacts. Provide flush green operators for motor start buttons, red extended head for motor stop buttons and black flush head operators for general control functions.
 - 5. Provide all push buttons, selector switches and pilot lights with engraved legend plates. Plates shall be 2.25" X 2.25" square "automotive style" White with black letters. Legend plates shall be suitable for outdoor use. Emergency stop legend plates shall be yellow with black letters.

2.9 DC POWER SUPPLIES

- A. Provide 24 Volt DC power supplies.
- B. Power supplies shall be 120 Volt input power, 24 VDC output.
- C. 24VDC DC power supplies shall be Allen Bradley 1606-XLE240E.
- D. Power supply shall have a mean time between failure (MTBF) of 1,058,000 hours at 24VDC and 10 amps (full load).

- E. All power supplies shall be UL listed. Substitute power supplies shall be shall only be provided with the GPO approval during shop drawing review.

2.10 ELECTRIC WIRING AND CONTROL

- A. Obtain control power from nearest power panel having 120 volts available. Provide branch circuit breaker in empty space in panel properly sized for load. Provide separate circuit breaker for each DDC cabinet.
- B. Control power may be derived from line side of a starter provided circuit is fused and all controls so energized are associated only with this starter and motor.
- C. Control transformer furnished as an integral part of a starter shall not be used as a power source for additional control.
- D. Starter disconnect or separate switch immediately adjacent to starter shall disconnect power from all line voltage or 120-volt control wiring entering starter.

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 00 40 FIELD EQUIPMENT CONTROL PANELS

25 00 00 50 - IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

- A. This Section defines identification and labeling requirements for control panels, instrumentation, including, control valves, control room instruments, panel instruments, wire, cable, and tubing.

1.2 REFERENCES

- A. TIA/EIA-606-A - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

1.3 SUBMITTALS

- A. Sample valve, damper and other instrument tags.
- B. Sample wire, cable and tubing tags.
- C. Sample panel tags.
- D. Sample tagging abbreviations (if used).
- E. Installation methods for each type and condition.

1.4 QUALITY ASSURANCE

- A. Tag each valve, damper, field devices and instruments according to contract documents.
- B. Where major devices are above ceiling, provide identification on ceiling grid to assist in locating device.
- C. Tags shall be machine generated and easily readable.
- D. Field tags shall be engraved brass, stainless steel or acrylic polymer suitable for outdoor use. Use only stainless tags for exterior locations.
- E. Do not mark on control panels, field devices and instruments with permanent markers, i.e.: felt pens or paint sticks.
- F. Install tags for easy readability.
- G. All identification in a single infrastructure must have the same format where possible.
- H. All control panel mounted devices shall be provided with engraved tags identifying the device.

- I. Mount control panel devices with double sided adhesive tape equivalent to 3M type 4004.
- J. Exterior control panel and equipment device tags shall be mounted with stainless steel screws. Screws shall be threaded into enclosures. Provide weatherproof washers and jam nuts in interiors of enclosures.
- K. Comply with TIA/EIA- 606A and Owner identification standards.
- L. Label Ethernet cables as per owners BMS network drawings.

PART 2 PRODUCTS

2.1 INSTRUMENT IDENTIFICATION

- A. Construction:
 - 1. 1/16" thick laminated phenolic plastic, white with black core for indoor applications.
 - 2. Nominal size of 1" high by 1 to 4" wide.
 - 3. Engraved in 1/4" high block characters.
- B. Self-adhesive is not permitted.
- C. Stainless steel, nominal size 2" X 4". Laser engraved 1" high block characters for exterior applications

2.2 CONTROL PANEL IDENTIFICATION

- A. Construction:
 - 1. 1/16" thick laminated phenolic plastic, white with black core.
 - 2. Nominal size of 2" by 4".
 - 3. Engraved 1" high block letters.
- B. Self-adhesive is acceptable where conditions will allow for permanent mounting and only within control panels.

2.3 VALVE AND DAMPER IDENTIFICATION

- A. Construction:
 - 1. 1/16" thick laminated phenolic plastic, white with black core or minimum 0.032" thick, polished brass or 316 stainless steel.
 - 2. Nominal size of 1" by 4".
 - 3. Engraved 5/8" high block letters.
- B. Hanging type only, self-adhesive is not acceptable for permanent mounting.

2.4 WIRE, CABLE AND TUBE IDENTIFICATION

A. Heat Shrink Tubing:

1. Manufacturer: Brady Permasleeve or equal. White labels with black text.
2. Labels shall be heat shrink tubing type. Heat shrink labels shall be used on wire, cable, and tubing except for vendor specific cables which may not be cut.
3. Multi Conductor Cable identification shall have overall cable identification and individual conductor identification.
4. Single conductors and cables shall be labeled per drawings.
5. All conductors and cables shall be labeled on both ends.
6. All terminal strips shall be labeled.
7. Provide device tags for terminal torque requirements.
8. I/O interface module terminals shall be marked utilizing factory applied labels.

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 00 50 IDENTIFICATION

25 00 00 60 - CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes Integrated Automation conductors and cable for signal transmission, communications, power, and other miscellaneous cables for complete integration of systems specified.

1.2 REFERENCES

- A. NEC 725 Class 1, Class 2, and Class 3 Remote Control, Signaling and
- B. Power Limited Circuits.
- C. NEC 800 Communication Circuits
- D. NEC 300 General Methods for Wiring and Materials

1.3 DEFINITIONS

- A. AWG: American Wire Gauge
- B. EMI: Electromagnetic Interference
- C. One thousand Voltamps
- D. Unwanted electrical or electromagnetic energy
- E. Signal Wire: Wire used to transmit an electrical signal such as voltage, amps, or resistance.
- F. PVC: Polyvinyl Chloride

1.4 SYSTEM DESCRIPTION

- A. Final connectors to control device.
- B. Communication cables for integrated systems.

1.5 SUBMITTALS

- A. Submit installation plan including:
 - 1. Recommended modifications to design documents.

2. Documentation for vendor specific limitations or modifications.
3. Sequence of installation.
4. Coordination requirements.

1.6 QUALITY ASSURANCE

- A. All work shall meet the requirements of the National Electrical Code, 2020 edition.
- B. All wiring shall be done in accordance with all local and national codes and authorities having jurisdiction.
- C. Ground and Bond according to manufacturer's recommendations. Refer to section 26 05 26 for grounding and bonding requirements.
- D. Review test and documentation structured communication cables for acceptance.
- E. Splicing communication and instrumentation cables is prohibited.
- F. Kinked cable is prohibited and must be replaced.
- G. Conform to requirements of National Electrical Code Articles 725 and 800, as well as local electrical codes, where required by the various systems.
- H. Ensure cable is free of tension at both ends. In cases where cable must bear stress, provide appropriate grips to spread stress over longer length of cable.
- I. Adhere to the following minimum distances to reduce effects of EMI:
 1. Five (5) inches from power lines of 2kVA or greater.
 2. Eighteen (18) inches from high voltage lighting (including fluorescent).
 3. Thirty-nine (39) inches from power lines of 5kVA or greater.
 4. Thirty-nine (39) inches from transformers and motors.
- J. Maintain separation of signal wire and wire carrying more than 100 VAC.
- K. Separate cable from other building systems.
- L. Install cables parallel and perpendicular to building walls. Coordinate space requirements with other trades.
- M. Conceal wiring in conduit in mechanical spaces, above ceilings, and other spaces where exposed wiring could be damaged.
- N. Where conduit is not required:
 1. Use cable tray with owner's permission.
 2. Cable shall be free of tension at both ends. In cases where cable must bear stress, provide appropriate grips to spread stress over longer length of cable.
 3. Provide conduit from cable tray to devices.

- O. Refer to Identification Section for label requirements.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store all products according to manufacturer's recommendations.
- B. Protect stored cable from vandalism and weather.
- C. Store cable and equipment no more than 6 weeks prior to installation.
- D. Maintain a minimum storage temperature of 50 F.

1.8 OWNER'S INSTRUCTION

- A. Provide 4 hours training on structured cable system.
- B. Include:
 - 1. Location of devices
 - 2. Terminations
 - 3. Troubleshooting
 - 4. Identification.

PART 2 PRODUCTS

2.1 ETHERNET COMMUNICATIONS CABLE

- A. Cabling Requirements: Ethernet communications
 - 1. Min Size: 22 AWG 600 volt stranded or solid.
 - 2. Min number of Conductors 8 conductor wired per TIA 568B standard.
 - 3. Jacket UL listed PVC plenum rated.
 - 4. Jacket color: Per manufacturer recommendations.
 - 5. Shielding: Provide shielded cable for all applications.
 - 6. Coordinate with GPO for cable identification requirements.

2.2 INSTRUMENTATION SIGNAL CABLE

- A. Cabling Requirements: 18 AWG, paired shielded 600V instrumentation tray cable constructed with stranded tinned copper, cross-linked polyethylene insulation, an aluminum/mylar shield with a stranded tinned copper drain wire and an overall chlorinated polyethylene jacket. Individual conductors are to be manufactured in accordance with UL Standard 66, Type XLPE/VW-1.
- B. Cable is to be manufactured in the USA in accordance with UL Standard 1277 and NEC listed Type TC, suitable for use in Class I Division II hazardous locations and approved for installation in cable trays per Article 336 of the National Electric Code.

- C. Cable may be installed in ducts or conduits, in trays or troughs and is approved for direct burial and outdoor applications.
- D. Jacket is to be sunlight and oil I & II resistant and cable is (UL) TC approved for 600V, 194°F Wet or Dry, and meets or exceeds the requirements of UL 1581 and 1202 (FT-4) 70,000 BTU/HR and ICEA T-29-520 210,000 BTU/HR flame tests.
 - 1. Min Size: 18 AWG 600 volt stranded.
 - 2. Min number of Conductors multiple (application specific).
 - 3. Jacket PE.
 - 4. Jacket Color Black.
 - 5. Shield individual pairs and overall pairs.
 - 6. Min Size: 18 AWG 600 volt stranded.

2.3 POWER WIRE

- A. All wiring within control panels shall be type MTW 600 volt and meet the following requirements.
- B. MTW Wire (Bare Copper) Construction:
 - 1. Conductor: Stranded Bare Copper.
 - 2. Insulation: Polyvinylchloride (PVC).
 - 3. Machine Tool Wire Approvals and Ratings: UL Rated MTW Wire within enclosure, THHN/THHW for field wiring.
 - 4. Maximum Temperature Rating: 221°F (UL and CSA), 221°F (TEW), 194°F (MTW)
 - 5. Voltage Rating: 600V.
 - 6. Flammability: Pass VW-1 Flame Test.
- C. Conductor color coding inside of control panels shall be as follows:
 - 1. Red: 120 VAC Control voltage.
 - 2. White 120 VAC control voltage neutral.
 - 3. Blue 24VDC.
 - 4. Blue with white stripe 24 VDC common
 - 5. Violet low voltage AC (less than or equal to 24 VAC).
 - 6. Pink low voltage AC (less than or equal to 24 VAC).
 - 7. Black: ungrounded power wiring within control panel.
 - 8. Green or green with yellow stripe: Grounded conductor.
 - 9. Yellow: Any conductor that has voltage present when enclosure disconnect is off (interlock wiring from remotely located equipment).

2.4 VFD CABLES

- A. VFD cable are required on ALL motors controlled with a VFD.
- B. Electrical conductors and equipment supplied by power conversion equipment as part of adjustable speed drive systems and servo drive systems shall be listed flexible motor supply cable marked RHH, RHW, RHW-2, XHH, XHHW, or XHHW-2VFD

- C. VFD cables shall be continuous from the drive cabinet to the motor terminal box.
- D. VFD cable shall be shielded and equipped with 300% ground.
- E. VFD cables shall be UL listed as flexible motor supply cables and meet the requirements of Paragraph 4.4.2.8 of NFPA 79 / 2018 Edition.
- F. VFD Cables shall be rated for no less than 1000 Volts RMS.
- G. VFD Cables shall have tinned stranded copper conductors.
- H. Wire gauge requirements and recommendations are based on 167 °F.
- I. VFD Cable shall be terminated in accordance with manufacturers guidelines for proper grounding and shielding.
- J. Follow the drive manufacturers installation guidelines for proper grounding requirements.

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 00 60 CONDUCTORS AND CABLES

25 00 00 70 - INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes all instrumentation.

1.2 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. NFPA 92A - Smoke-Control Systems.
- C. NFPA 92B - Smoke Control Systems in Atria, Covered Malls, and Large Areas.
- D. UL-864/UUKL Smoke Control Listing.
- E. UL 555/555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.
- F. NFPA 70 National Electric Code.
- G. NFPA 79 Electrical Standard for Industrial Machinery.
- H. UL 508A Standards for Industrial Control Panels.
- I. UL 508 Standards for Industrial Equipment.
- J. ANSI: American National Standards Institute.
- K. API: American Petroleum Institute.
- L. ASME: American Society of Mechanical Engineers.
- M. ASTM: American Society for Testing and Materials (ASTM International).
- N. DIN: Deutsches Institut für Normung.
- O. IEC: International Electrotechnical Commission.
- P. IEEE: Institute of Electrical and Electronics Engineers.
- Q. ISA: International Society of Automation formerly Instrument Society of America.
- R. ISO: International Organization for Standardization.
- S. FM: Factory Mutual Laboratories (FM Approved).

1.3 SYSTEM DESCRIPTION

- A. Meters, gauges and sensors for control and monitoring.
- B. Thermowells, Instrument Piping and Valves related to control and monitoring.
- C. Temperature and Pressure Switches.
- D. Power monitoring.
- E. Refrigerant monitoring.
- F. Control valves and electric actuators.
- G. Flow meters (air, water, steam and natural gas).
- H. Level sensors and transmitters.
- I. Temperature and Humidity Transmitters
- J. Lightning protection for instrumentation.

1.4 SUBMITTALS

- A. Submit installation plan including:
 - 1. Recommended modifications to design documents.
 - 2. Documentation for vendor specific limitations or modifications.
 - 3. Sequence of installation.
 - 4. Coordination requirements.
 - 5. Instrument cut sheets and manufacturers data.
 - 6. Complete Instrument model numbers.
 - 7. Installation manuals and instructions.
 - 8. Loop sheets for instrumentation.
- B. The catalog numbers in the specification are intended to guide the controls contractor in the selection of the instrumentation. It is the contractor's responsibility to provide the proper instrumentation for the chiller control system.

1.5 QUALITY ASSURANCE

- A. Coordinate timely delivery of materials.
 - 1. Coordinate installation activities of inline devices such as immersion wells, pressure tapping's, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations with mechanical contractor.
 - 2. Coordinate with Mechanical and Electrical contractor on valves or equipment furnished by others but are to be integrated into the control system.

- B. Install all control devices in appropriate enclosure and in an accessible location.
- C. Provide junction box or enclosure to protect wiring and allow conduit connection for all sensors.
- D. Mount duct instrumentation on top or side of horizontal ducts. Do not mount on bottom of duct.

PART 2 PRODUCTS

2.1 THERMOWELLS

- A. Provide all thermowells as part of instrumentation package:
 - 1. Thermowells shall be threaded 316 Stainless steel.
 - 2. Insertion length shall follow industry standards.
 - 3. Typically, insertion length shall be 1/3 the pipe diameter.
 - 4. Overall length shall consider insulation thickness.
 - 5. Thermowell shall be utilized on all process piping and vessels to allow for the removal without disturbing the process.
- B. Acceptable manufacturers:
 - 1. Rosemont 114C
 - 2. Yokagowa WH3
 - 3. Wika TW 15
 - 4. Or Equal.

2.2 RTDs

- A. All temperature sensors shall be PT 100 3 wire RTD type.
- B. The use of thermistors is not allowed.
- C. RTDs mounted in thermowells shall utilize thermal heat transfer paste.
- D. RTDs single point temperature sensors shall be:
 - 1. Platinum RTD type, with the following minimum performance.
 - 2. Accuracy: +/- 0.1% @ 32°F | +/- 0.25% @ 70°F | +/- 1.0% @ 266°F
 - 3. Operating Range: -40 to 275°F.
 - 4. Conformance: DIN-IEC 751 Class A.
 - 5. Sensor material: 316 stainless steel.
- E. Acceptable manufacturers:
 - 1. Pyromation RAF185L
 - 2. Temco RTD 00361
 - 3. Or Equal

2.3 TEMPERATURE TRANSMITTERS

- A. All temperature transmitters shall have 4-20 Ma output.
- B. All temperature transmitters shall Allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All temperature transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All temperature transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. Temperature transmitter shall have Input type that is selectable: Thermocouples, 2-, 3-, and 4-wire RTDs, ohms and DC millivolts.
- F. All Temperature transmitters shall have a configurable LCD digital display.
- G. LCD shall INCLUDE 5-digit numerical display with °C, K, °F, °R, % and mV, 0 to 100 % bargraph and dot- matrix display.
- H. Temperature transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- I. Temperature transmitter housings shall be stainless steel for exterior applications.
- J. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- K. Temperature transmitter housings for interior use shall be polyurethane resin baked finish.
- L. Acceptable manufacturers:
 - 1. Yokagowa: YTA-110-EA2DA2DN
 - 2. Rosemont: 3144PD1A1NAM5WR3
 - 3. PR Electronics: 7501A3A2A11

2.4 GAUGE PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have 4-20 Ma output.
- B. All pressure transmitters shall allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot- matrix display.

- G. Pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- H. Pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable manufacturers:
 - 1. Yokagowa: EJA530E-JBS4N-012EN/FF1/D1
 - 2. Rosemont: 2088G2S22A1M4DW
 - 3. Endress & Hauser: PMC71-ABC1P6GAAAA73
- L. Provide 316 stainless steel block and bleed valves for all gauge pressure transmitters.
- M. Acceptable manufacturers:
 - 1. Parker Model HLS2V
 - 2. Anderson Greenwood M25VIS-4M
 - 3. WE Anderson BBV0F

2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- B. All differential pressure transmitters shall allow remote communications (HART protocol)
- C. All differential pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All differential pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All differential pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot-matrix display.
- G. Differential pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy or SCS14A stainless steel (option, equivalent to SS316 cast stainless steel and ASTM CF-8M).
- H. Differential pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable Manufacturers:

1. Yokagowa EJA110E-JHS4G-8-12E (contractor to verify capsule measurement range during submittal process.)
 2. Rosemount 2051CD3A02A1AS5D4 (contractor to verify capsule measurement range during submittal process.)
 3. Endress &Hauser PMD75-ABC7H62VCAA (contractor to verify capsule measurement range during submittal process.)
- L. Provide 316 stainless steel three valve manifolds for all differential pressure transmitters.
- M. Acceptable manufacturers:
1. Parker Model HLS2V
 2. Anderson Greenwood M4TVIS-4 SSA2
 3. WE Anderson BBV-1F
 4. Swagelok SS-V3NBF8-FL.

2.6 MAGNETIC FLOW METERS

A. GENERAL REQUIREMENTS (magnetic flowmeters):

1. The meter shall measure flow rate with electrodes mounted in the flow stream.
2. The electrode seal shall not be in direct contact with the flowing medium to protect against electrode sealing failure.
3. The meter shall be available with an optional field replaceable electrode assembly in 1"–12" sizes permitting cleaning and maintenance of the electrodes without the need to remove the meter from the line.
4. A PFA Teflon liner shall be supplied which is injection molded in the meter body to ensure liner integrity.
5. The liner shall have an embedded metal reinforcing grid for sizes 1" through 16" to protect against collapse in vacuum services and cuts due to abrasion.
6. Ground rings shall be included as standard to prevent liner damage during installation and for liner protection in abrasive slurries.
7. The flowtube shall be all welded construction, bolted assemblies are not permitted.
8. Meters shall conform to established ISO face to face standards and shall be available in both wafer and flanged style process connections.
9. The standard performance specification shall be 0.35% of reading with an optional high accuracy calibration rated at 0.2% of reading.

B. GENERAL REQUIREMENTS (magnetic flowmeter converter):

1. Shall be Remote mounted with factory supplied cables to flowtube.
2. Shall be microprocessor-based with Hart communication superimposed on the 4-20 mA line.
3. The converter shall excite the field coils using a dual frequency excitation technique utilizing a 75 Hz high frequency component for stable flow measurements in slurries and fast response time for short batch processes. Optionally a 165 Hz high frequency component shall be available for very high concentration slurries to ensure greater stability and quicker response.
4. The converter shall provide diagnostics to detect insulating coatings on the electrodes and provide an alarm function.

5. The converter shall permit the measurement of fluids with conductivities as low as 1 microS/cm.
6. The converter outputs shall include a 4-20 mADC signal, an open collector pulse output rated 30VDC, 200 mA, as well as outputs for high flow/low flow alarm, self-diagnostic fault indication, bi-directional flow indication, totalizer switch and a flow switch.
7. Shall include a 3-line LCD, backlit, full dot matrix display. The display shall be programmable to indicate various display possibilities, including a bar graph for flow rate indication and a graphical representation of the extent to which the electrodes may be coating. The display shall include infrared switches to permit programming through the glass without the need to open the enclosure cover.
8. Flow Converter to be AXF11. Provide factory supplied cable from flowtube to flow converter.

C. Acceptable Manufacturers:

1. Flowmeter and signal converter are to be the Yokogawa ADMAG AXF series (high accuracy series).
2. Rosemount Model 8750W series with remote flow converter (high accuracy model.)
3. Badger Meter M4000 series with remote flow converter.

2.7 CONTINUOUS LEVEL TRANSMITTERS

- A. Provide guided radar continuous level transmitters for level measurement in cooling tower basins.
- B. The contacting level gauge shall operate on the Time Domain Reflectometry (TDR) principle.
- C. Shall provide output signals directly proportional to process level.
- D. The instrument shall be capable of measuring process level of liquids, pastes, and slurries.
- E. The device shall be capable of measuring liquid products with dielectric constants greater than 1.4 with coaxial design sensors, greater than 1.9 with Dual/Twin sensors, and 1.9 – 10 or greater with single element sensors when mounted within 3" – 6" of a ground reference such as a vessel wall, stilling well or metal cage. No mounting limits for the Single element sensors in product dielectrics greater than 10.
- F. The converter shall be powered by 13 – 30 Vdc Intrinsically safe, or 14 – 30 Vdc explosion proof 2- wire source and be available with five sensor options; single rod, single cable, dual rod, dual cable or coaxial.
- G. Probe and signal converter shall form an integral compact unit that mounts directly to a standard ANSI flange, probe style dependent.
- H. No external process seals, stilling wells, tubing, isolation valves or reflector targets shall be vacuum to 580 required.
- I. The sensor assembly shall form an integral process seal rated for operation from full 580 psig (40 bar) in product temperatures up to 392°F

- J. It shall be possible to remove and reinstall the signal converter module without violating or compromising process vessel integrity.
- K. The signal converter modules shall be interchangeable and be capable of being installed on a sensor assembly without adjustment or matching of components.
- L. One passive 4-20mA current output shall be provided as standard for continuous output directly proportional to the process level, distance or volume independent of the local display value.
- M. The output shall have HART capability for remote control and interrogation and configuration upload/download by a remote handheld unit or personal computer.
- N. The signal converter shall be equipped with an integral backlit LCD display with simple, clear alphanumeric text prompting and messaging.
- O. Start-up and configuration may be accomplished without the use of external devices via local display and keypad.
- P. The operating software shall employ measured value plausibility checking to ensure that the output display signal is within anticipated norms.
- Q. A volume strapping table shall be included as standard.
- R. The unit shall not require FCC site approval for operation.
- S. The instrument shall be manufactured in an ISO 9001 approved facility.
- T. Mount Sensor probe in stilling well for tanks and basins with turbulent flow.
- U. Acceptable manufactures:
 - 1. Drexelbrook Impulse Series.
 - 2. Vega Vegaflex 81 series.
 - 3. Rosemount 3300 series.

2.8 LIGHTNING PROTECTION

- A. Provide surge suppression for all exterior mounted transmitters.
- B. Acceptable manufacturers:
 - 1. Bourns Series 1669-01/ 05.
 - 2. Phoenix Contact S-PT1-2PE-24DC.
 - 3. Factory installed Lighting protection furnished with instrument.

2.9 ELECTRICALLY ACTUATED VALVES

- A. Furnish and install Electrically actuated butterfly valves size 2" or larger where shown on plans or called out within the specifications for open close duty.

- B. Furnish and install Electrically actuated ball valves size 1-1/2" or smaller where shown on plans or called out within the specifications for open close duty.
- C. Furnish and install Electrically actuated control valves sized as shown on plans or called out within the specifications for modulating duty.
- D. Butterfly valves Shall be one-piece double flanged and comply with ISO 5752 – Table 2 (Short pattern) face-to face with extended neck to allow for 2" of piping insulation.
- E. Valve body shall be constructed of ductile iron. Provide flange hole drilling per international flange standard as specified.
- F. A non-corrosive bushing and a self-adjusting stem seal shall be provided. No field adjustment shall be necessary to maintain optimum field performance.
- G. Stem shall be one-piece design, constructed out of 416 stainless steel.
- H. Disc to stem connection shall be an internal double "D" design with no possible leak paths in the disc-to-stem connection. External disc-to stem connections such as disc screws or pins are not allowed.
- I. Disc shall be constructed of 316 stainless steel. Disc casting shall be spherically machined and hand polished.
- J. Stem shall be mechanically retained in the body neck and no part of the stem shall be exposed to the line media.
- K. Valve seat shall be a bonded EPDM with a primary hub seal and a molded flange O-ring suitable for weld-neck and slip-on flanges.
- L. The seat shall totally encapsulate the body isolating the body from the line media and no flange gaskets shall be required.
- M. Valve shall be rated for bubble-tight shut-off at 150 psi. Valve shall be factory tested to 110% of rated pressure.
- N. The use of reduced valve discs is not permitted.
- O. Acceptable manufacturers for butterfly valves:
 - 1. Bray Model 3A.
 - 2. Keystone figure 55.
 - 3. Val-Matic American-BFV.
- P. Ball valves under 2" shall be threaded stainless steel construction.
- Q. 1000 PSI working pressure.
- R. 3-piece swing out design for easy maintenance.
- S. Direct mounting valve per ISO5211.

- T. Full port for unrestricted flow.
- U. 316 stainless steel body, ball and stem.
- V. Blow out proof stem.
- W. RTFE ball seats extend cycle life.
- X. Triple RTFE/Viton stem seal design, live loaded.

2.10 ELECTRIC VALVE ACTUATORS

- A. Furnish and install electrically operated valve actuators for all open close and modulating duty valves as shown on the P&ID drawings.
- B. Actuators shall be designed for valve operation to ensure proper function in accordance to EN 15714-2:2010 electric actuators for industrial valves - basic requirements. Depending on application actuators shall be designed for ON-OFF, short-time duty (S2-15min) respectively Class A and B according to EN 15714-2 or MODULATING, intermittent duty (S4-25%) respectively Class C with up to 1.200 starts per hour; no. of starts depending on actuator size and output speed.
- C. Actuator shall have a design life of 10.000 OPEN-CLOSE-OPEN cycles, each consisting of 30 turns per sense of rotation and must be suitable for operating in any mounting position. Actuator design must provide simple setting, testing, maintenance and repair.
- D. Actuator settings shall be performed non-intrusive via push-buttons at motor control without special tools or instruments (e.g., battery backed setting tool). A wireless Bluetooth interface shall be available. Microsoft Windows based software running on a conventional computer shall be available to allow actuator set-up and diagnoses.
- E. Electrical connection of actuators to be multi pin plug and socket connector, allowing quick disconnection in case of maintenance or repair. In order to prevent loss of screws during commissioning or maintenance, all covers shall be fixed with captive screws. In order to minimize the amount of spare parts required, parts such as covers, plug and sockets, parts must be interchangeable throughout all model sizes.
- F. Torque-transmitting housings must be made of cast iron, except motor housing. No plastic parts of any type shall be used, except for electric / electronic components, operating knobs / levers, indicator mechanism and sealing elements as far as applicable.
- G. Depending on valve application, actuators shall be self-locking. Self-locking shall remain active if actuator is switched to hand-operation-mode. For non-self-locking actuators with high output speeds a mechanical anti-back drive device shall be provided attached to the actuator.
- H. Valve mounting dimensions shall be according to ISO 5210 with use of a plug sleeve connection adapting to valve shaft. For rising stem applications, actuator design must allow actuator removal from output drive without disturbing the valve function.

- I. Motors must be suitable for operating at 3 phase power supply voltage of 480Volt AC (+/- 10%), 60Hz or 115Volt (+/- 10%) and shall be specifically designed for valve-actuator operation, characterized by high starting torque, low stall torque and low inertia. Motors shall be totally enclosed non-ventilated type (TENV). Motor housings and covers to be made of sea water resistant aluminum. Motor-insulation must be in accordance with IEC 85 Class F (155° C). Motors must be protected by 1 or 3 thermal monitoring devices, which are embedded in motor windings. Motor connections shall be internal by means of plug and socket.
- J. Motors must be totally separated from lubricant-filled gearing of actuator, allowing replacement of motor without loss of lubricant regardless of mounting position. Motors shall have a dog coupling as mechanical connection to actuators worm shaft.
- K. Actuator motors must develop full torque when power is turned on. All motors shall be of high starting torque type to facilitate 'unseating' of the valve. Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.
- L. One actuator size (same outside dimensions) shall be available covering output speeds from 4 to 180 rpm for a given torque range, to avoid over sizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator output torque must be available at 90 % of nominal voltage.
- M. In order to enable proper sizing of applicable electric equipment, actuator supplier has to disclose current value at maximum setting torque. Actuator shall be capable of opening and closing the valve against full differential pressure (150 PSI) within specified time on valve data sheet.
- N. No battery backed limit sensing shall be used to avoid actuator malfunction in case of power failure. Actuators shall have a hall sensor principle based absolute encoder for limit sensing with a resolution of 3° or better. Actuator shall not be equipped with a battery.
- O. Torque sensing shall be of mechanical sliding worm principle with torque values independently settable for 'OPEN' and 'CLOSE' direction. No electronic torque sensing derived from motor current or piezo-electric torque sensing at worm shaft. Torque setting shall be possible for 40% to 100% of rated torque.
- P. Integral motor controls shall be microprocessor based and include mechanically and electrically interlocked reversing contactors for ON-OFF duty and solid-state contacts (thyristors) for MODULATING duty actuators.
- Q. Local controls shall consist of motor controls, push buttons OPEN-STOP-CLOSE-RESET, lockable selector switch LOCAL-OFF-REMOTE. Local controls shall be electrically attached to actuator via plug and socket connection. It shall be possible to re-position local controls at every 90°, so that push buttons and indication lights will face the operator.
- R. In case actuators have to be mounted in difficult to access positions, it shall be possible to separate local controls (including motor controls) from actuator. A wall bracket shall be available to mount local controls / motor controls near valve actuator for distances up to 50 m cable length.
- S. Depending on detailed project design, actuator version shall be as follows:

1. ON-OFF, short-time duty S2-15 min with hard wired signals OPEN-STOP-CLOSE inputs to the PLC.
 2. MODULATING, intermittent duty S4-25% with hard wired communication via 4-20mA input signal, including a 4-20mA output signal, internally powered. Detailed wiring diagram to be supplied with submittal documents.
- T. Detailed wiring diagram shall show all relevant signals such as valve position, end positions (OPEN/CLOSE), selector switch position and high torque alarm in OPEN/CLOSE direction. In addition to this, actuator must provide a dedicated fault signal if there is a phase failure, motor protection tripped and/or high torque in OPEN/CLOSE direction or if hand wheel is engaged.
- U. All control signals, communication signals as well as main power supply must be wired to a multi pin plug and socket for customer connection. Terminal compartment shall provide sufficient space to accommodate the possible maximum number of incoming wires. A minimum of three cable entries must be provided for motor power cable and digital/ analogue inputs and outputs. Each cable entry shall be properly sealed by cable glands during site installation. Cable glands shall be chosen by contractor, responsible for wiring during commissioning phase.
- V. Each actuator shall provide an adequately sized internal and external connection for grounding.
- W. In order to prevent condensation, a heater must be installed inside the actuator, suitable for continuous operation. Actuator must provide an alarm signal in case of failure of anti-condensation heater.
- X. Protection class of actuator, including motor, shall be IP 68, according to EN 60529 against submersion up to 8 m head of water for at least 96 hours. During submersion it must be possible to operate the actuator at least 10 times.
- Y. Actuators must be equipped with a hand wheel for manual operation. Clockwise operation of hand wheel shall cause clockwise movement of output drive. Hand wheel shall be clearly marked with an arrow and the word 'CLOSE'.
- Z. Hand wheel engagement shall be of spring-loaded push mechanism type and required manual declutching. Actuator must provide a switch signal when in manual mode.
- AA. Under manual operation, hand wheel shall drive the worm shaft. Self-locking shall be maintained in hand operation. Motor must be disengaged during manual operation. Hand wheel shall automatically disengage when the electric motor is energized.
- BB. Hand wheel must be sized allowing easy manual operation of output drive. The over torque indication shall be active in manual operation as well as motor operation, thus allowing a signal to be provided when the set-torque has been reached.
- CC. Bearings shall be of antifriction or self-lubricating type. Bearings shall not require any maintenance between general overhauls. Power gears shall be made from heat treated steel. Worm-wheels shall be made of bronze material. Actuator gear housing shall be filled with an adequate quantity of lubricant. Re-lubrication between general overhauls shall not be required.
- DD. Two nameplates, made of aluminum, shall be attached to each actuator; one on the motor housing, showing all relevant motor data, one on the actuator housing showing all relevant actuator data. Special information, such as valve tag no., shall be shown if required. Nameplates

shall be securely fixed to actuator and motor, so that they cannot be removed or scratched off during shipment, installation, operation or maintenance.

- EE. Actuator corrosion protection shall fulfill the requirements of EN ISO 12944-2, classification of environments C4 with a specified salt spray test of 720h. Actuator painting must be performed in such a way, that no corrosion takes place under ambient conditions as specified. All outside screws or bolts shall be made of stainless steel (A2). Actuators shall be corrosion protected with a primer coating and a two-layer powder coating consisting of an epoxy coating and a polyurethane top coating with a total film thickness of at least 140µm. Final color shall be manufacturers standard colors.
- FF. Each actuator shall be factory tested. Tests shall be performed in accordance with IEC standards as far as applicable. A final inspection record shall be supplied with each actuator showing general actuator data, nominal current, no load current, starting current, power factor at rated torque, output speed, torque setting, limit setting (turns/stroke), high voltage test, functional test (including all options) and visual test.
- GG. Supplier to provide storage- installation- and operation instruction as well as electric wiring diagram, dimensional drawings and technical data sheet including motor data as per manufacturer standard.
- HH. Provide worm gear boxes for larger butterfly valve to reduce the actuator torque required for proper valve operation. Electric actuators and gearboxes shall be supplied by the same manufacturer.
- II. Worm gearboxes shall be specifically designed for butterfly or ball valves and damper operation and shall meet the torque / lifetime requirements of EN 15714-2 (electric actuators for industrial valves – basic requirements).
- JJ. The gearboxes shall be self-locking.
- KK. The gearboxes shall have a worm wheel and worm shaft, including adjustable mechanical end stops.
- LL. For motor operation in modulating duty, the worm wheel shall generally be made of bronze.
- MM. If required, worm gearboxes shall be equipped with a primary planetary gearing to reduce input torque.
- NN. The gearbox housing shall be made of cast iron (GG). Aluminum housing material (torque transmitting parts) is not acceptable.
- OO. The gearbox housing shall be filled with grease to guarantee adequate lubrication in any mounting position and a long service life.
- PP. Special self-lubricating bearings shall be provided to accept radial forces on the worm shaft.
- QQ. A thrust bearing shall carry the resulting axial load.
- RR. For motor operation, the gearboxes should withstand actuator tripping torque.

- SS. Enclosure protection shall be at least IP68, according to EN 60529. Worm gearboxes shall be sealed by radial seals or O-rings.
- TT. The adjustable mechanical end stop shall be designed as travelling nut to protect the gearbox housing / valve stem from excessive force. The design shall guarantee a defined stop when reaching the end of travel (valve is closed). The end stop shall be equipped with safety wedge discs to guarantee a mechanical stop block principle.
- UU. The end stop design shall accept the input torques as axial forces within the worm shaft, the load not being transmitted to the gearbox output / valve stem.
- VV. Travel limitation with stop screws (end stop screws as used for segment or quadrant type) placed in the gearbox housing shall not be permitted, as protection against excessive torque cannot be guaranteed.
- WW. The mechanical end stop shall be easily adjustable during commissioning and maintenance work on site to guarantee proper seating of the valve during operation. Swing angle shall be set at OEM.
- XX. Acceptable manufacturers:
 - 1. Auma SA actuators, GA gear boxes, AM 01.1 controls for open close duty. AUMA SA actuators, GA gear boxes, AM 01.2 controls for modulating duty.
 - 2. Rotork IQ3 actuators, gearboxes, standard controls.
 - 3. Limitorque MX/QX actuators, standard controls, direct mount.

2.11 ROOF MOUNTED TEMPERATURE AND HUMIDITY TRANSMITTER

- A. Provide roof mounted temperature and humidity transmitter for temperature, humidity and wet bulb temperature.
- B. Transmitter shall incorporate a thin film polymer capacitive HUMICAP® humidity sensor that is field replaceable and have an accuracy of $\pm 1\%$ RH (0...90% RH) and $\pm 1.7\%$ RH (90...100% RH) at 59...77 °F.
- C. Temperature sensor shall be a platinum 100 Ω RTD with an accuracy of $\pm 0.36^\circ\text{F}$ at 68°F.
- D. Electronics to be protected in a NEMA 4 enclosure.
- E. Transmitter to be powered by 10...35 VDC, 24 VAC or optional 100...240 VAC and provide two linear selectable analog outputs of: 4 to 20 mA, 0 to 20 mA, 0 to 1 V, 0 to 5 V, or 0 to 10 V, as well as serial output of standard RS232C (optional RS 485/422 or Ethernet).
- F. Transmitter shall also have a third analog output for wet bulb temperature.
- G. Transmitter shall operate over the 0 to 100% RH range and -40° to 140°F temperature range.
- H. Transmitter shall be microprocessor based giving the option to calculate and directly output dew point, frost point, absolute humidity, wet bulb temperature, mixing ratio, enthalpy, ppm (volume or weight), partial pressure of water vapor, and saturation vapor pressure.

- I. Transmitter shall incorporate a local graphical/numerical display in its cover.
- J. Display shall indicate Relative Humidity (0 to 100%), Temperature (-40° to 140°F) and dew point.
- K. Transmitter shall be able to be calibrated, without disturbing operation, using a single point electronic transfer standard.
- L. Provide NIST traceable calibration certificate for each instrument.
- M. Combined Pressure, Humidity and Temperature Transmitter shall be Vaisala model PTU-307. Provide analog outputs for pressure, temperature, (wet bulb) and RH.
- N. Provide Vaisala Meteorological Installation Kit HMT-330MIK to enable PTU-337 to be installed outdoors to obtain reliable measurements for meteorological purposes.

2.12 REFRIGERATION GAS MONITORING SYSTEM

- A. Provide a stationary refrigerant gas leak detection system designed to alarm at a specified level of refrigerant gas in monitoring areas. The instrument shall be a wall mounted device with onboard sensor, using a pump to draw aspirated samples through tubing to the sensor, from the areas where refrigerant gases are most likely to concentrate. The instrument shall be capable of sequentially sampling from multiple different areas and report data specific to each monitored channel.
- B. The refrigerant gas monitor shall meet the following specifications:
 - 1. Coverage: single sensor onboard
 - 2. Sensor type: Non-dispersive infrared (NDIR) sensor)
 - 3. Furnish 4 channel monitor.
 - 4. Gases detected: HFC, HFO, HCFC, CFC.
- C. The detector shall have an on-board gas library containing calibration data for >50 refrigerant gases, configurable to select a specific refrigerant for optimized accuracy of measurement.
- D. Accuracy: ± 1 ppm $\pm 10\%$ of reading from 0-1,000 ppm.
- E. Response time: T90 = 5 seconds plus sample transport time.
- F. Sample transport time: 19 seconds per 100 ft.
- G. Minimum detectable level: One part per million (1 ppm).
- H. Automated zero-point calibration: The instrument shall periodically sample clean air and automatically perform a zero-point calibration.
- I. Operating Temperature: 32°-122°F. Ambient Humidity: 5% to 90% RH.
- J. Sampling Mode: sequential per channel. Pump rate: 6 liters per minute.

- K. User interface: Display screen and keypad; gas reading simultaneously displayed per channel for all channels.
- L. Communications: Modbus RTU: Baud rate 9,600 or 19,200, configurable.
- M. 4 x SPDT relays: low alarm, medium alarm, high alarm and fault.
- N. Provide dual channel analog output; 4-20 mA.
- O. Certification: UL 61010-1.
- P. Manufacturer: Bacharach, model HGM-MZ, or approved equal.

PART 3 SEE 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 00 70 INSTRUMENTATION

PART 4 EXECUTION

4.1 EXAMINATION

- A. Prior to start of any work, 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.
- B. Promptly request clarification and instruction or report any conflicts, inadequate conditions or missing information in the Project Documents. Report unacceptable conditions immediately.
- C. Inspect site to verify that equipment can be installed as shown.
- D. Examine drawings and specifications for work of others.
- E. Perform necessary changes in specified work caused by failure or neglect to report discrepancies.
- F. Follow drawings and specifications to ensure that all equipment installed under this section(s).
- G. Verify manufacturer's recommended installation instructions do not conflict with contract documents. Report any discrepancies or conflicts.

4.2 INSTALLATION

- A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- B. Provide sufficient slack, flexible connections and isolation to allow for equipment vibration.
- C. Verify elevations and measurements prior to installation of materials.
- D. Beginning installation means contractor accepts existing conditions.
- E. Conceal wiring in conduit in mechanical spaces, above hard ceilings, and other spaces where exposed wiring could be damaged.
- F. Provide temporary service, routing of service, or other temporary requirements to minimize downtime of service.
- G. 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.)
- H. Arrange for necessary openings in building to allow for admittance of all apparatus.
- I. 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.

- J. Coordinate all systems in order to minimize access door requirements.
- K. Coordinate final locations, sizes and rough-in dimensions for access doors.
- L. Verify door swings for proper clearance before installing. The working space, which is measured from the enclosure front, must not be less than the distances contained in NEC Table 110.26(A)(1).
- M. Perform of the work in a safe and competent manner and use of industry accepted installation procedures required for the work.

4.3 ENCLOSURES

- A. Enclosures for all controllers and instruments except those furnished by equipment manufacturers for factory mounted controls.
- B. Provide NEMA type 12 enclosures for dry indoor locations.
- C. Provide NEMA type 4X Stainless control panel enclosures in outdoor locations or indoor locations (including maintenance spaces) where water damage is possible.
- D. Label enclosures with respective unique ID numbers in accordance with section 25 00 00 50.
- E. Mount local control panels at convenient locations adjacent to and independent of equipment served. Install control panels in locations as shown on drawings and with proper clearance.
- F. Mount cooling devices, receptacles and incandescent lights (if applicable) on enclosure sides.
- G. Mount top of panels between 5 and 6 ft above floor. Mount panels at consistent height.
- H. Provide control panels where more than one control device requires field mounting.
- I. Instrument mounting:
 - 1. Ensure connections can be easily made and ample room exists for servicing each item. Every component in and on enclosures shall be able to be removed individually without affecting other components and without the need to move other components.
 - 2. Install devices prior to terminating wire or tubing.
 - 3. Rigidly attach instruments with properly sized stainless-steel screws or bolts so they may be removed.
 - 4. Do not install instruments on panel sides, except for cooling devices, receptacles, and lighting, devices.
 - 5. Provide gaskets for instruments penetrating panel exterior and seal in accordance with NEMA standards. Entire enclosure shall meet NEMA standard after installation of required devices.
- J. Knockouts:
 - 1. Distortion of panels is not permitted as a result of machining cutouts or mounting instruments and devices.

2. Cutouts shall be smooth and without irregularity from desired shape.
3. Flame cutting or arc-cutting is not permitted.
4. Align knockouts, sub-panels, and drilling for mounting to keep devices grouped and in vertical and horizontal alignment.
5. Provide rubber grommets in cutouts for wiring or tubing to prevent chaffing or scarring of insulation or jacketing of wiring or tubing.

K. Mounting fasteners:

1. Minimum size for panel fastening anchors shall be 9/16" for floor anchors and 3/8" bolt for wall anchors. Increase anchor sizes as required for heavy panels.

L. Floor Mounted Panels:

1. Unless otherwise specified, install floor mounted control panel(s) on four 4" concrete equipment pad(s) with grout as required.
2. Install two (2) anchors for each four (4) feet of equipment length or minimum of four (4) anchors. Decrease anchor spacing for heavy panels as required. Bolt equipment to pad using cap screws and washers.
3. Do necessary grouting after equipment is installed and leveled. Grouting material shall be Owner approved cement grout; mixed and placed in accordance with manufacturer's recommendations. Remove leveling shims and wedges after grout has hardened. Re-grout Shim and wedge areas after shims or wedges are removed.

M. Wall Mounted Panels:

1. Provide one anchor for every 4'-0" of outside perimeter for wall mounted panels; minimum anchors for wall mounted panels shall be 4. Decrease anchor spacing for heavy panels as required.
2. Provide clear space for dressing out wiring, cables and tubing entering panel. Provide 4"2 unrestricted clear space for each inch of conduit size or each square inch of wiring duct size, with 4" x 4" being minimum area, in alignment with entering conduit or wiring duct, for bringing wiring into panel and routing to other locations. This space shall be sufficiently accessible to enable pulling wiring, cables, or tubing into panel for termination with initially installed equipment in place.

N. Wiring:

1. Provide flexible sleeves for protection of each wire bundle that passes across door hinge. Allow sufficient slack in wiring bundles so that door can fully open. Provide separate bundles for analog and discrete wiring crossing door hinges separated by > 6".
2. Install wire and cabling so that any item may be removed without interrupting circuit power or other terminations.
3. Use solder less spade-type compression lugs for wiring terminations except for pressure plate type terminations.
4. Identify power circuit.
5. Install wiring along vertical or horizontal runs to present neat appearance. Angled runs are not allowed.
6. Provide copper grounding lugs for electrical grounding of metal panels. Size lugs for system requirements but shall be less than #8.
7. Neatly land and terminate stranded conductors in terminal blocks. Do not remove strands of stranded wire out to make wiring fit terminal.

8. Fuses or circuit breakers shall be readily accessible and easily identified. Properly label each fuse or circuit breaker. Install circuit breakers and fuses in clear space as required by NEC.
9. Connect controller network cabling in accordance with manufacturer's connection practices and as shown on drawings.

O. Terminal Blocks:

1. Land cables on terminal blocks prior to controller terminations.
2. Assure ease of accessibility of terminal blocks.
3. Connect no more than 2 conductors under each terminal screw.
4. For terminal blocks located between 3" deep or deeper wiring duct, install terminal blocks on raised channel to facilitate ease of connection to terminal block.
5. Label terminal blocks.
6. Group terminal blocks in sequential manner following I/O type and device tag name.
7. Grouping or placement shall not compromise NEC wiring classification.

P. Power:

1. Terminate power wiring within 6 inches of enclosure entrance.
2. Include fused terminal strip with blown fused indicator.
3. Identify power source panel and breaker.

4.4 WIRING DUCT

- A. Install wiring duct along vertical or horizontal runs to present neat appearance.
- B. Permanently fasten wire duct into sub-panels using 10/32 screws.
- C. Support lower sidewall on horizontal runs of plastic wiring duct with bracing to avoid sagging.
- D. Install wiring between devices and terminal blocks in wiring duct except for dressing out to make terminations.
- E. Wiring duct fill shall not exceed 40% of wiring duct volume.
- F. Provide labels on wiring duct designating AC and DC wiring.

4.5 WIRING TROUGH

- A. Provide wiring trough above or parallel to field control panels.
- B. Route wiring through wire trough to minimize wire tension and allow re-routing of wire when necessary.
- C. Wiring:
 1. Neatly arrange, bundle with nylon tie-wraps, and support with adhesive backed tie-wrap supports wiring which must be outside wiring duct. Provide flexible sleeves for protection

- of each wire bundle that passes across door hinge. Allow sufficient slack in wiring bundles so that door can fully open. Provide separate bundles for analog and discrete wiring crossing door hinges separated by > 6".
2. Install wire and cabling so that any item may be removed without interrupting circuit power or other terminations.
 3. Use solderless spade-type compression lugs for wiring terminations except for pressure plate type terminations.
 4. Identify power circuit.
 5. Install wiring along vertical or horizontal runs to present neat appearance. Angled runs are not allowed.
 6. Provide copper grounding lugs for electrical grounding of metal panels. Size lugs for system requirements but shall be less than #8.
 7. Neatly land and terminate stranded conductors in terminal blocks. Do not remove strands of stranded wire out to make wiring fit terminal.
 8. Fuses or circuit breakers shall be readily accessible and easily identified. Properly label each fuse or circuit breaker. Install circuit breakers and fuses in clear space as required by NEC.
 9. Connect controller network cabling in accordance with manufacturer's connection practices and as shown on drawings.
 10. Connect 120 VAC or low voltage power, as required, to each I/O module and to processor rack power supply.
 11. Connect I/O to terminal blocks including controller I/O spares and spare I/O cards.

D. Terminal Blocks:

1. Land cables on terminal blocks prior to controller terminations.
2. Assure ease of accessibility of terminal blocks.
3. Connect no more than 2 conductors under each terminal screw.
4. For terminal blocks located between 3" deep or deeper wiring duct, install terminal blocks on raised channel to facilitate ease of connection to terminal block.
5. Label terminal blocks.
6. Group terminal blocks in sequential manner following I/O type and device tag name.
7. Grouping or placement shall not compromise NEC wiring classification. Give special attention to Intrinsically Safe wiring.

E. Power:

1. Terminate power wiring within 6 inches of enclosure entrance.

4.6 FLOOR LEVEL COMMUNICATIONS CABLE

- A. Install cable in approved pathways only.
- B. Provide appropriate shielding to eliminate equipment noise from VFD's and other equipment.
- C. Provide additional shielding and grounding per applicable manufacturer's recommendations and/or job site conditions.
- D. Label cable according to Section 25 00 00 50, 2.4

4.7 INSTRUMENTATION SIGNAL CABLE

- A. Provide signal cables for instrumentation.
- B. Install cable in approved pathways.
- C. Provide appropriate shielding to eliminate equipment noise from VFD's and other equipment.
- D. Provide isolated instrument grounding system as per manufacturer's recommendations.
- E. Terminate instrument cables at terminal blocks or terminal strips in cabinets.
- F. Label cable according to Section 25 00 00 50, 2.4.

4.8 POWER WIRE (50 VOLTS OR LESS)

- A. Unless otherwise specified or noted, provide final power connections including conduit, wire, and/or control panel disconnect switches to all control devices from appropriate electrical j-box.
- B. Provide power cables for instrumentation and devices.
- C. Install cable in approved pathways.

4.9 POWER WIRE (GREATER THAN 50 VOLTS)

- A. Provide final power cables and connections for instrumentation and devices.
- B. Install cable in approved pathways.
- C. Label cables according to Section 25 00 00 50, 2.4.

4.10 PATHWAYS

- A. Verify routing and termination locations of pathways prior to rough-in.
- B. Coordinate equipment, floor and wall and roof penetrations with appropriate trades.
 - 1. Provide penetrations for pathways.
 - 2. Provide appropriate sleeves for penetrations.
 - 3. Provide fire-stopping as described in section 07 84 00.
- C. Provide pathways for all work within this division.
 - 1. Provide non-continuous pathway systems from wall sensor conduit stub to associated controller.
 - 2. Provide continuous enclosed conduit pathway systems in mechanical spaces, electrical spaces, exposed areas and in any areas not specifically allowed to be non-continuous pathways.

3. Provide continuous enclosed conduit pathway systems for Smoke Control System.

- D. Size conduit and boxes by circular mil size of cable in conduit or box.
- E. Minimum conduit size is 3/4".
- F. Maximum length of flexible conduit is 5 feet.
- G. Refer to Division 26 for additional requirements.

4.11 PROTECTION

- A. Conduit and raceway penetrations through walls, floors, and ceilings require fire stopping. Refer to Section 07 84 00.
- B. Provide sleeves for penetrations. Coordinate sleeve selection and application with Section 26 05 44.
- C. Furnish information as to size and location of built-in openings required.
- D. Do not cut, remove, or pierce general or mechanical insulation, fire rated walls, ceilings, or steelwork without prior permission and instruction.
- E. Provide conduit to protect pneumatic tubing outside of panels.
- F. Provide appropriate protection for all work within this division.
- G. Refer to Division 26 for additional requirements.

4.12 INSTRUMENT IDENTIFICATION

- A. Label each instrument with hardware tag and software name.
 - 1. Instrument hardware tagging shall be according to symbols and tag numbers used on control panel drawings.
 - 2. Instrument software name shall be according to database generated point name. Coordinate with section 25 00 10 50.
- B. Size label to accommodate instrument tag number and description.
- C. Affix label to permanent to instrument or housing (if direct instrument mounting is unreasonable).
- D. Fastening Methods for indoor applications:
 - 1. Self-adhesive or double-side adhesive tape.
 - 2. Epoxy Cement as required
- E. Fastening Methods for weather exposed or other conditions where self-adhesive is impractical:

1. Field tags: Use Round head, No. 0 x 3/16", Type U, metallic drive screw, (0.075 diameter, blunt), size 51 (0.067") drill, stainless steel. Cadmium plated screws are not allowed. Similar screw may be substituted.
 2. Panel face: Use Phillips panhead, No. 2-56 x 5/16", Type T, self-tapping sheet metal screw (0.086 diameter., blunt, notched), size 48 (0.076") drill, stainless steel. Cadmium plated screws are not allowed. Similar screw may be substituted.
- F. Provide control panel interior mounted instrument tags. Engraved legend shall be instrument tag number

4.13 CONTROL PANEL IDENTIFICATION

- A. Provide control panel face mounted instrument tags as required. Engraved legend form as follows:
1. PROCESS EQUIPMENT IDENTIFICATION
- B. DEVICE FUNCTION INSTRUMENT TAG NUMBER
1. Instrument tag number shall be per owner's standard.
 2. Coordinate label tags and format prior to purchasing or installation.
- C. Provide phenolic tag for each controller.

4.14 VALVE AND DAMPER IDENTIFICATION

- A. Provide valve and damper tags for controlled equipment.
- B. Valve and damper tags number shall be per contract documents and owner's standard.
- C. Coordinate label tags and format prior to purchasing or installation.

4.15 WIRE, CABLE AND TUBE IDENTIFICATION

- A. Provide cable sheaths labeling on both ends approximately 6 inches from the termination in case the cable becomes separated from its termination.
- B. Provide a complete documented cable record for Integrated Automation systems.
- C. Label Coverage area cables at each end:
1. Label terminating end with distribution location identification serving terminal device.
 2. Label distribution end with terminal device destination.
- D. Label instrumentation cable and tubing at each end:
1. Label terminating end with panel device tag.
 2. Label distribution end with instrument device tag.

4.16 VARIABLE FREQUENCY DRIVE SYSTEMS

- A. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.
 - 1. Installation shall follow all manufacturer requirements, instructions and drawings.
 - 2. Comply with manufactures literature for proper installation and grounding requirements.
 - a. https://literature.rockwellautomation.com/idc/groups/literature/documents/in/drives-in001_en-p.PDF
- B. At a minimum, the start-up service shall include:
 - 1. Perform Pre-Power Check
 - 2. Megger Motor Resistances: Phase-to-Phase and Phase-to-Ground.
 - 3. Verify system grounding per manufacturer's specifications.
 - 4. Verify power and signal grounds.
 - 5. Check connections.
 - 6. Check environment.
- C. Drive Power-up and Commissioning:
 - 1. Measure Incoming Power Phase-to-Phase and Phase-to-Ground.
 - 2. Measure DC Bus Voltage.
 - 3. Measure AC Current Unloaded and Loaded.
 - 4. Measure Output Voltage Phase-to-Phase and Phase-to-Ground.
 - 5. Verify input reference signal.
- D. All measurements shall be recorded.
- E. Drive shall be tuned for system operation.
- F. Drive parameter listing shall be provided as part of the final documentation.

4.17 CONDUIT SYSTEMS

- A. Conduit installation methods shall comply with Division 26 and this section.
- B. All exterior conduit shall be galvanized rigid steel.
- C. All exterior hardware, unistrut, pipe clamps, shall be stainless steel.
- D. All exterior disconnects and junction boxes shall be NEMA 4X Stainless steel.
- E. All electrical work in an around cooling towers shall be PVC coated rigid steel:
 - 1. All conduit prior to coating shall conform to Federal Specification WW-C- 581E, ANSI specification C80.1 and UL 6.
 - 2. PVC coated conduit is "Hot Dipped" galvanized inside and out with hot dipped galvanized threads. The "Hot Dipped" galvanized threads are coated with blue urethane.

3. Conduit shall be labeled with the UL Label having only one exception requiring the use of threaded fittings.
 4. Conduits shall be UL Verified for adhesion performance (Conduit: 240 hrs. oven conditioning at 212 degrees F, 600 hrs. salt fog chamber, peel testing).
 5. The interior of the PVC coated conduit has a blue urethane coating of a nominal thickness of .002".
 6. The exterior of the PVC coated conduit has a PVC coating of a minimum thickness of .040" applied by dipping in liquid plastisol.
 7. All PVC coated conduit conforms to NEMA Standard No. RN-1.
 8. PVC coated conduit shall be bendable without damage to either interior or exterior coating.
 9. A .002" nominal thickness coating of blue urethane is applied to the exterior, the interior of fittings and couplings.
 10. .040" minimum thickness coating of PVC is applied to the exterior of all fittings.
 11. The PVC coating on all form 8 fittings forms a gasket-like flange of at least 5/16" wide and .040" thick covering the top of the fitting around the opening.
 12. The PVC coating on all form 8 covers forms a gasket-like flange of at least 5/16" wide and .040" thick covering the bottom of the cover and mating with the flange of the fitting.
 13. Stainless steel encapsulated screws are supplied with all form 7 and form 8 fittings.
 14. All hubs on fittings and couplings have a PVC sleeve extending one pipe diameter or 2 inches, whichever is less. The I.D. of the sleeve to be equal to the O.D. of the uncoated pipe.
- F. All flexible conduits shall be liquidtight flexible conduit, type UA with integral copper ground.
- G. All conduit terminations into NEMA 12, 13, 4 or 4X rated enclosures, control panels, wireway and junction boxes shall terminate with threaded hubs:
1. Threaded hubs located outdoors shall be malleable iron.
 2. Threaded hubs shall be PVC coated when utilized on PVC coated conduit systems.
 3. Threaded hubs shall have insulated throats.

END OF SECTION 25 00 00 XX

SECTION 25 00 10 - HOT WATER SKID CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Section includes the general requirements for the Integrated Automation systems. Integrated Automation Systems are utilized on Production equipment and systems, chiller and boiler plants, scrap processing and dust collection systems, electrical substations, HVAC equipment, pollution control equipment, air, water (domestic hot and chilled), steam and natural gas systems.
- B. RELATED DIVISIONS AND SECTIONS
 - 1. All project sections within Division 01 – General Requirements
 - 2. Section 22 05 00 - Basic Plumbing Materials and Methods
 - 3. Section 22 05 53 - Identification for Plumbing Piping and Equipment
 - 4. Section 23 05 00 - Basic Mechanical Materials and Methods
 - 5. Section 23 05 53 - Identification for mechanical Piping Ductwork and Equipment
 - 6. Section 23 21 16 - Hydronic Piping Specialties
 - 7. Section 23 21 23 - Hydronic Pumps
 - 8. Section 23 22 16 - Steam and Condensate Heating Piping Specialties
 - 9. Section 23 25 23 – HVAC Water Filtration Equipment
 - 10. Section 23 57 00 – Heat Exchangers
 - 11. All project sections within Division 25 – Integrated Automation
 - 12. All project sections within Division 26 – Electrical
- C. Where architectural features govern location of work, refer to architectural drawings and coordinate with other trades.

1.2 REFERENCES

- A. This section includes any rules and regulations of Federal, State, local authorities, and utility companies in force at the time of execution of contract.
- B. Agencies or publications referenced herein refer to the following:
 - 1. ADA: Americans with Disabilities Act
 - 2. ANSI: American National Standards Institute
 - 3. ASHRAE: American Society for Heating, Refrigeration, Air-Conditioning Engineers
 - 4. ASTM: American Society for Testing and Materials
 - 5. BICSI: Building Industry Consulting Services International
 - 6. EIA: Electronic Industries Association
 - 7. FCC: Federal Communications Commission
 - 8. ICEA: Insulated Cable Engineers Association
 - 9. IEEE: Institute of Electrical & Electronics Engineers
 - 10. ISO: International Organization for Standards
 - 11. NEC: National Electrical Code (2020)
 - 12. NECA: National Electrical Contractors Association
 - 13. NEMA: National Electrical Manufacturers Association

- 14. NETA: National Electrical Testing Association
- 15. NIST: National Institute of Standards & Technology
- 16. OSHA: Occupational Safety and Health Administration
- 17. TIA: Telecommunications Industries Association
- 18. UL: Underwriters Laboratories, Inc.

1.3 DEFINITIONS

- A. AHU: Air Handling Unit.
- B. ATC: Automatic Temperature Control.
- C. ATU: Air terminal Unit.
- D. AWG: American Wire Gauge (standard wire size measurement)
- E. BAS/BMS: Building Automation System/Building Management System.
- F. Device: Intelligent controller or other automated monitoring piece of equipment.
- G. CD: Compact Disc used for data storage.
- H. Commissioning: Process to ensure installation and functionality is per design.
- I. Enterprise: Top level of integrated systems for overall logistical monitoring and business planning.
- J. EMS: Enterprise Management System.
- K. FCU: Fan Coil Unit.
- L. PLC: Programmable Logic Controller.
- M. I/O: Hardware inputs and outputs.
- N. Instrument: Device used to sense inputs or control outputs or both.
- O. Integration: Connection of disparate systems to a common platform using communication protocols.
- P. IP Address: Internet Protocol node address
- Q. IT: Information Technologies.
- R. O&M: Operation & Maintenance Manuals.
- S. Object: Hardware or Software component such as a device or point.
- T. Point: Single hardware input/output or software data objects such as set points and attributes.

- U. Point list: List of inputs, outputs and parameters for specific systems.
- V. RFI: Request for Interpretation.
- W. Stand-Alone: the ability to function upon loss of communication.

1.4 SYSTEM DESCRIPTION

- A. The hot water control system includes integration, control and monitoring of the hot water production systems utilized for hydronic heating:
 - 1. Hot water production including integration to PLC control system.
 - 2. Hot water distribution pump controls.
 - 3. All instrumentation and accessory hardware shown on the P&ID drawings.
 - 4. All variable frequency drives and control panels as shown on the P&ID drawings.
 - 5. All PLC hardware and control panels as detailed in the specifications.
 - 6. All electrically operated valves as shown on the P&ID drawings.
 - 7. All modulating control valves as shown in the P&ID drawings.
 - 8. Local operator interface terminals required for local control and monitoring.
 - 9. All other instrumentation shown on the P&ID drawings.

1.5 CONTRACTOR REQUIREMENTS

- A. Hot water control system includes but is not limited to labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, network termination to GPO supplied network hardware, integration equipment, instrumentation and controls and integrated automated systems. The contractor is required to provide the following:
 - 1. Procurement and installation of integrated automated systems hardware.
 - 2. Procurement and installation of automation systems SCADA software if specified in other sections.
 - 3. Integration of equipment systems with the automation systems SCADA software. This includes equipment supplied by others as shown in contract drawings.
 - 4. Procurement of ancillary equipment installed by others. This includes but is not limited to: labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, instrumentation and controls and integrated automated systems.
 - 5. Controls contractor is required to furnish and install the following, and is responsible for the equipment and software as shown below as well as the contract documents:
 - a. PLC control cabinets completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.
 - b. VFD control panels completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.
 - c. Field mounted line or load reactors or harmonic filters for VFD's.
 - d. All control valves and actuators with position feedback. Valves shown in the specs and on the contract drawings. Valves installed by piping contractor.

- e. All temperature sensors shown in the specs and on the contract drawings. Provide all mounting accessories and thermowells for pipe mounting of temperature sensors.
- f. All magnetic flowmeters. Installed by piping contractor.
- g. Differential pressure transmitters. To be installed by piping contractor.
- h. Pressure transmitters as specified or as shown on contract drawings. Provide block and bleed valves for all pressure transmitters.
- i. Any PLC and VFD panel supplemental air conditioners that may be shipped loose and field installed by the contractor.
- j. Computer equipment mounted in control panels as shown on contract drawings, or as specified in other sections.
- k. SCADA software as shown on contract drawings or as specified in other sections.
- l. Computer Servers and workstations as shown on the contract drawings or as specified in other sections.
- m. UPS systems as shown on the contract drawings.
- n. Any owner supplied equipment as specified in the contract documents.
- o. All Ethernet cabling from GPO supplied network equipment. Contractor will coordinate with owner on cable labeling requirements.

1.6 SUBMITTALS

- A. Contractor is to submit a complete schedule of submissions before submittal process.
- B. Submit each section independent and separate from other sections. For each product submission, contractor is to provide specification section and product number.
- C. Include only products within referenced specification section submission.
- D. Product Data: For each product submission, include the following:
 - 1. Table of contents for each submission.
 - 2. Submit each section independent and separate from other sections. Include only products within referenced specification section submission.
 - 3. Product data sheets for all required components and accessories.
 - 4. Submit manufactures checklist & calibration documentation for calibrated instrumentation.
 - 5. Identify actual product model number used for each drawing.
 - 6. Identify any proposed modifications to system design. (Specifications or Drawings)
 - 7. Organize product data based on specification Section, Part, and Article.
 - 8. A paragraph-by-paragraph specification compliance report indicating compliance for each numbered paragraph. The following format shall be used in completing the compliance report:
 - a. Comply—without exception.
 - b. Qualify—meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.
 - c. Does not comply—cannot meet specified function.
- E. Integration Plan: Network architecture and communications concepts/diagrams. Network architecture includes but is not limited to:

1. Nodes.
2. Switches, include GPO furnished network hardware.
3. Integrated systems and/or sub-systems.
4. Dedicated I/O locations.
5. Non-Ethernet communications cabling.
6. Coordination submission. Include an integration matrix detailing systems and protocols to be used. This includes equipment such as chiller, RO water systems, boilers and humidification systems.
7. Workflow processes to integrate systems.
8. Include communication hardware (gateways), software, and protocols to implement full systems integration.
9. Identify proposed enhancements or deviations from project documents. Include specific drawings or specifications impacted.
10. Provide coordination efforts to accommodate complete integration of systems including:
 - a. Vendor protocol requirements.
 - b. Vendor point list.
 - c. Submit PLC ladder logic for review.
 - d. Submit maintenance schedules for all controller, valves, dampers, and instrumentation.
 - e. Complete set of control and wiring diagrams. Include panel layout drawings if not shown on contract drawings.

F. Start-up Plan:

1. Provide complete start up plan.
2. Coordination of equipment controlled and monitored.
3. Workflow process to start equipment.
4. Equipment start-up requirements.
5. Checklist.
6. Intended sequence of work items.
7. Start dates of individual work items.
8. Duration of individual work items.
9. Planned delivery dates for major material and equipment, and expected lead times.
10. Milestones indicating possible restraints on work by other trades or situations.
11. Coordinate equipment startup to coincide with construction schedules.
12. Provide multiple startup and commissioning trips at no additional cost to owner to allow for phased startup of the mechanical systems.

G. Owner Instruction and Training Plan:

1. Provide 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.
 - h. Recommended classroom training and schedule.

H. Record Documents:

1. Include field condition updates.
2. Document material, make and model numbers where appropriate.
3. Update details, schedules, risers, etc.
4. I/O point as-built drawings.
5. Sequence details, modifications, or updates.
6. Control loops including final set-points and parameters.
7. Mark and detail on coordination drawings, exact locations of equipment installed.
8. Panel details for each unique panel.
9. PLC program backups.
10. Operator interface screen program backups.
11. SCADA application program backups.
12. All passwords and security configuration for all hardware and software.
13. All configuration and programming software for all controls as specified by owner and contract documents.

I. O&M Manuals:

1. O&M manuals for all equipment supplied under this contract. Include complete parts lists and bill of materials for PLC control panels and VFD panels.
2. At minimum, submit two electronic copies and four hard copies.
3. Do not include previously submitted product data.
4. Include a table of contents.
5. Tab manual based on specification chapters or sections.
6. Network architecture and communications concepts/diagrams.
7. Uploading and downloading software to the field hardware.
8. Finely detailed descriptions of all software programs.
9. Complete set of software engineering manuals.
10. Complete system design and engineering manual same as used by manufactures personnel.
11. Application Programming.
12. CD of any configuration tools used in project.
13. Operator instructions or User Manual.
14. Calibration and/or verification sheets for all instrumentation including but not limited to:
 - a. Liquid Flow Meters.
 - b. Air or gas Flow Meters.
 - c. CO2 Sensors.
 - d. Temperature Sensors.
 - e. Humidity Sensors.
 - f. Pressure transmitters.
 - g. Differential pressure transmitters.
 - h. Airflow monitoring stations.

J. Project Maintenance Manuals:

1. Include a table of contents.
2. 1 copy on CD three hard copies.
3. Organize by manual by specification section number.
4. Index sheet listing contents in alphabetical order.
5. Include the following:

- a. Installation instructions.
 - b. Manufacturer's operating and maintenance instructions (not product submittals).
 - c. Factory and field-test records, including calibration and factory setup.
 - d. Printout of application control programs, one electronic copy and 2 hard copies.
 - e. Snapshot printout of each system installed.
 - f. Signed checklist of each system showing complete I/O checkout and system commissioning.
 - g. Training schedule and course description catalog.
 - h. Archived backup of software, drawings, and record documents.
 - i. Installation contractor and service representative information.
 - j. Licensing and warranty information including provided software.
 - k. Documentation verifying all software licenses have been transferred to GPO.
- K. Submit a User Workstation Planning Session Plan for each subject:
- 1. Graphics Generation.
 - 2. Tag naming.
 - 3. Alarm management.
 - 4. Report Configuration.

1.7 QUALITY ASSURANCE

- A. All systems, equipment, components, accessories, and installation hardware must be new, free from defects, and currently in production.
- B. All work shall be compliant with applicable national and local codes.
- C. Demonstrate project compliance to Engineers satisfaction including construction and integration.
- D. Provide the same manufacturer components of a given type product throughout project.
- E. Support future compatibility for no less than 15 years with the ability to upgrade existing field panels and extend new field panels on an installed network.
- F. Digital equipment furnished under this contract shall have been tested and made to comply with limits of Class A computing device pursuant to Subpart J of Part 15 of FCC Rules.
- G. Maintain NEC workspace clearances:
 - 1. Install and operationally check systems utilizing factory-trained competent technicians skilled in the setting and adjustment of equipment used in this project.
- H. Test, adjust, and calibrate all end instruments before startup and commissioning.
- I. Follow project communication protocol for all correspondence. Any changes, decisions, etc. must be properly documented. The Engineer will not issue verbal directions. Verbal interpretations, clarifications, conversations, etc. are non-binding without proper documentation.
- J. Request for Interpretation (RFI) shall include:

1. Referenced drawing and/or Specification Section number.
 2. Single request per RFI.
 3. Single proposed solution per RFI.
 4. Attached sketch of solution (if applicable).
 5. Attached specification verbiage (if applicable).
 6. Incomplete RFI's will be returned without response.
 7. Contact person.
- K. RFI answers are for clarification only and do not authorize additional work or change orders.
- L. Install devices in appropriate enclosure and in an accessible location.
- M. Install systems and devices in a neat, workmanlike manner and in accordance with manufacturer's recommendations.
- N. Continually monitor the field installation for code compliance and quality workmanship.
- O. Remove and re-install any systems or devices where installation is deemed of poor quality by Owner or Engineer.
- P. Provide software and firmware updates prior to and within 2 months of substantial completion.
- Q. Lead the coordination effort to ensure integration of various systems prior to installation.
- R. Comply with all health and safety regulations.
- S. Include automatic restart logic for loss of power, safeties, fire alarm shutdown, etc.
- T. Provide components not specifically indicated or specified, but necessary to make system function within the intent of contract documents.
- U. All electrical products to be listed and labeled by UL and comply with NEMA Standards.
- V. Provide a competent and experienced Project Manager.
- W. Engineering services shall be performed by factory-trained engineers.
- X. System shall be installed by factory trained mechanical and electrical installers either in direct employ of this Contractor or by subcontractors who are under direct supervision of this Contractor.
- Y. Use only manufacturer trained technicians who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided under this section.
- Z. Coordinate with the Owner to ensure that the control system will perform on the Owner's network environment without disruption to any of the other activities taking place on that LAN.

PART 2 PRODUCTS

2.1 GENERAL CONTROL PRODUCTS

- A. GPO has standardized on Allen Bradley Controls as the basis for all building monitoring and production control systems. GPO has standardized on Inductive Automation Ignition software for HMI Visualization and monitoring software. GPO has invested significant capital in training, software and support agreements; therefore, the use of alternate equipment and software is not permitted.
- B. All control systems shall be based upon the Allen Bradley Control Logix platform. This includes all equipment and systems detailed in section 1.4.
- C. Allen Bradley Control hardware:
 - 1. The processors shall be Control Logix 5580 series processors.
 - 2. Provide a minimum of 2 spare slots in each rack or 20% spare rack space for each I/O rack.
 - 3. Provide 1756-PA75 series power supplies for common spare parts inventory.
 - 4. Analog input modules shall be 1756-IF16. Modules shall be configured for single ended current mode. Provide 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 5. Analog output modules shall be 1756-OF8. Module shall be configured for current output mode. 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 6. Digital input modules shall be 1756-IA16 or 1756-IB16. Provide 1492-IFM20 interface module and pre wired factory assembled cable.
 - 7. Digital output modules shall be 1756-OA16. Provide 1492-XIM20120-16R Relay interface module and pre-wired factory assembled cable.
 - 8. Provide din rail mounted signal conditioners to provide isolation for analog inputs from field devices that are powered form separate DC supply.
 - 9. 24VDC DC power supplies shall be equivalent to Allen Bradley 1606-XL240E. Power supply shall have a mean time between failure (MTBF) of 1,058,000 hours at 24VDC and 10 amps (full load). All power supplies shall be UL listed. Substitute power supplies shall be shall only be provided with the GPO approval during shop drawing review.
 - 10. Miniature circuit breakers shall be one, two or three pole design. UL 489 listed:
 - a. Dual rated for AC or DC applications.
 - b. DIN rail mounted miniature circuit breakers up to 63-amp current rating.
 - c. Current limiting design to provide fast short circuit interruption. that reduces the
 - d. Suitable for reverse feed applications.
 - e. Suitable for branch circuit device.
 - f. Fulfills UL 489, CSA C22.2 No.5 as well as IEC 60947-2 Standards.
 - g. Thermal-magnetic overcurrent protection.
 - h. Three levels of short circuit protection, categorized by B, C and D curves.
 - i. SWD (switching duty) rated circuit protection.
 - j. Size breakers and trip curve in accordance with UL 508A.
 - k. Circuit breakers are not allowed on motor loads with the exception of electrically operated valves. All other motor loads will be protected with class J fuses.
 - 11. Terminal blocks shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated at a minimum of 30 amps at 600 Volts and shall accommodate wire sizes of 24 to 10 AWG.

12. Terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 volt and shall accommodate wire sizes of 14 to 1/0 AWG.
13. Grounding terminal blocks shall be green/ yellow in color din rail mountable and UL listed. Grounding terminal blocks shall be rated at a minimum of 35 amps at 600 volts and shall accommodate wire sizes of 26 to 10 AWG.
14. Grounding terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 Volts and shall accommodate wire sizes of 14 to 1/0 AWG.
15. All terminal blocks shall have a short circuit rating of no less than 100KA per UL 508A.
16. Terminal blocks and other panel components shall be mounted on din rail. Din rail shall be 1.38" x .30". Zinc-Plated Clear Chromated Steel and be UL listed.
17. I/O interface modules shall be mounted on elevated din rail. Elevated din rail shall be Symmetrical Rail 1.38" x .30" 2.26". high 3.28' long Copper-Free Aluminum and UL listed.
18. Push Buttons shall be 30 mm Allen Bradley 800H- series. No substitutions. Provide 2 NC –NO contact blocks for each operator. Button colors shall be green for start motor applications, red extended head for motor stop applications and black for general control functions. Provide other colors as determined by owner.
19. Selector switches shall be 1.18" Allen Bradley 800H series with standard operators. No substitutions Provide 1 NC-NO contact for each position.
20. Pilot lights shall be 1.18" Allen Bradley 800H series full voltage (12 to 130 Volt AC/DC) LED indicators. No substitutions. Provide color coded lenses for the following functions. Red indicates fault condition, Green indicates run or normal condition, blue indicates automatic mode, amber indicates manual or bypass mode. Provide color coded lenses as shown on contract drawings.
21. Provide all push buttons, selector switches and pilot lights with engraved legend plates. Plates shall be 2.25" x 2.25" square "automotive style" White with black letters. Legend plates shall be suitable for outdoor use. Emergency stop legend plates shall be yellow with black letters.

PART 3 EXECUTION INSTALLATION AND COMMISSIONING

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Store products according to manufacturer's recommendations.
- B. Store products in original manufacturers packaging.
- C. All material shall be stored in a climate-controlled environment.
- D. Do not store products more than 3 months prior to schedule installation.
- E. Coordinate deliveries of material with construction schedule and appropriate trades.

3.2 SCHEDULING

- A. Included in this project are connections to equipment provided by others. Coordinate deliveries, final locations, factory mounting, and various connections required.

- B. Coordinate activities with contract project schedule:
- C. Ensure integration activities are incorporated into project schedule.
- D. Communicate requirements to prevent potential damage from paint, dust, water, weather, etc.
- E. Monitor and take measures to assure protection for all equipment.
- F. Coordinate all IT requirements with owner and contract project schedule.

3.3 WARRANTY

- A. Submit warranty documentation upon completion of project or phase and acceptance by Engineer and Owner:
 - 1. Warranty start date shall be the date of substantial completion.
 - 2. Warranty period shall be 1 year on parts and labor and include 2 years of software upgrades.
- B. Repair or replace systems or parts found defective at no cost to Owner including: but not limited to:
 - 1. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period.
 - 2. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
 - 3. Include parts, labor, and necessary travel during warranty.
- C. Scheduled preventive maintenance (p.m.) visit twice a year during the warranty period to audit system performance:
 - 1. Each p.m. visit shall include exercising each control loop and control sequence for performance.
 - 2. A log of each loop tested and each control sequence verified shall be reviewed with the Owner.
- D. Provide vendor specific warranty information.
- E. Provide services incidental to proper performance.

3.4 SYSTEM STARTUP

- A. Start equipment according to manufactures recommendation.
- B. Document system start up time and date.
- C. Document person(s) performing startup.

- D. Coordinate startup with other trades.
- E. All equipment installation is to be complete before startup.

3.5 OWNER'S INSTRUCTIONS

- A. Provide a factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of each piece of equipment or system. Instructors shall be thoroughly familiar with all aspects of the subject matter.
- B. The training shall be specifically oriented to the system and interfacing equipment installed.
- C. Include classroom instruction and field demonstration.
- D. Classroom instruction should include at a minimum:
 - 1. Detailed review of and as-built documentation and conditions.
 - 2. In depth discussion of theory or sequence of operations.
 - 3. Review organization and usability of O&M documentation.
 - 4. Maintenance procedures and schedules.
- E. Field instruction should include at a minimum:
 - 1. Normal maintenance procedures.
 - 2. Demonstration of operation.
 - 3. Demonstration of safeties and interlocks.

3.6 COMMISSIONING

- A. Participate in the commissioning process.
- B. Provide on-site programming support throughout the commissioning process to make program modifications as directed by the commissioning engineer.
- C. Provide documentation in final O&M package that reflects any changes made during the commissioning process.
- D. Provide necessary personnel during the commissioning process to test and validate all field devices and PLC I/O.
- E. Provide on-site start up support for each phase of equipment startup as well as final system commissioning.

END OF SECTION - 25 00 10 - HOT WATER SKID CONTROL SYSTEM

SECTION 25 00 10 10 - LOCAL OPERATOR INTERFACE TOUCH SCREENS

PART 1 SEE SPECIFICATION 25 00 00 10 "LOCAL OPERATOR INTERFACE TOUCH SCREENS"
FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 10 "LOCAL OPERATOR INTERFACE TOUCH SCREENS"
FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 10 LOCAL OPERATOR INTERFACE TOUCH SCREENS

25 00 10 20 - VARIABLE-FREQUENCY MOTOR CONTROLLER

PART 1 SEE SPECIFICATION 25 00 00 20 "VARIABLE-FREQUENCY MOTOR CONTROLLER" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 20 "VARIABLE-FREQUENCY MOTOR CONTROLLER" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 20 VARIABLE-FREQUENCY MOTOR CONTROLLER

25 00 10 30 - VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 SEE SPECIFICATION 25 00 00 30 "VARIABLE-FREQUENCY DRIVE SYSTEMS" FOR
CRITERIA.

END OF PART - 25 00 10 30 VARIABLE FREQUENCY DRIVE SYSTEMS

25 00 10 40 - FIELD EQUIPMENT CONTROL PANELS

PART 1 SEE SPECIFICATION 25 00 00 40 "FIELD EQUIPMENT CONTROL PANELS" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 40 "FIELD EQUIPMENT CONTROL PANELS" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 40 FIELD EQUIPMENT CONTROL PANELS

25 00 10 50 - IDENTIFICATION

PART 1 SEE SPECIFICATION 25 00 00 50 "IDENTIFICATION" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 50 "IDENTIFICATION" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 50 IDENTIFICATION

25 00 10 60 - CONDUCTORS AND CABLES

PART 1 SEE SPECIFICATION 25 00 00 60 "CONDUCTORS AND CABLES" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 60 "CONDUCTORS AND CABLES" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 60 CONDUCTORS AND CABLES

25 00 10 70 - INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes all instrumentation.

1.2 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. NFPA 92A - Smoke-Control Systems.
- C. NFPA 92B - Smoke Control Systems in Atria, Covered Malls, and Large Areas.
- D. UL-864/UUKL Smoke Control Listing.
- E. UL 555/555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.
- F. NFPA 70 National Electric Code.
- G. NFPA 79 Electrical Standard for Industrial Machinery.
- H. UL 508A Standards for Industrial Control Panels.
- I. UL 508 Standards for Industrial Equipment.
- J. ANSI: American National Standards Institute.
- K. API: American Petroleum Institute.
- L. ASME: American Society of Mechanical Engineers.
- M. ASTM: American Society for Testing and Materials (ASTM International).
- N. DIN: Deutsches Institut für Normung.
- O. IEC: International Electrotechnical Commission.
- P. IEEE: Institute of Electrical and Electronics Engineers.
- Q. ISA: International Society of Automation formerly Instrument Society of America.
- R. ISO: International Organization for Standardization.
- S. FM: Factory Mutual Laboratories (FM Approved).

1.3 SYSTEM DESCRIPTION

- A. Meters, gauges and sensors for control and monitoring.
- B. Thermowells, Instrument Piping and Valves related to control and monitoring.
- C. Temperature and Pressure Switches.
- D. Power monitoring.
- E. Refrigerant monitoring.
- F. Control valves and electric actuators.
- G. Flow meters (air, water, steam and natural gas).
- H. Level sensors and transmitters.
- I. Temperature and Humidity Transmitters
- J. Lightning protection for instrumentation.

1.4 SUBMITTALS

- A. Submit installation plan including:
 - 1. Recommended modifications to design documents.
 - 2. Documentation for vendor specific limitations or modifications.
 - 3. Sequence of installation.
 - 4. Coordination requirements.
 - 5. Instrument cut sheets and manufacturers data.
 - 6. Complete Instrument model numbers.
 - 7. Installation manuals and instructions.
 - 8. Loop sheets for instrumentation.
- B. The catalog numbers in the specification are intended to guide the controls contractor in the selection of the instrumentation. It is the contractor's responsibility to provide the proper instrumentation for the heating control system.

1.5 QUALITY ASSURANCE

- A. Coordinate timely delivery of materials.
 - 1. Coordinate installation activities of inline devices such as immersion wells, pressure tapping's, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations with mechanical contractor.
 - 2. Coordinate with Mechanical and Electrical contractor on valves or equipment furnished by others but are to be integrated into the control system.

- B. Install all control devices in appropriate enclosure and in an accessible location.
- C. Provide junction box or enclosure to protect wiring and allow conduit connection for all sensors.
- D. Mount duct instrumentation on top or side of horizontal ducts. Do not mount on bottom of duct.

PART 2 PRODUCTS

2.1 THERMOWELLS

- A. Provide all thermowells as part of instrumentation package:
 - 1. Thermowells shall be threaded 316 Stainless steel.
 - 2. Insertion length shall follow industry standards.
 - 3. Typically, insertion length shall be 1/3 the pipe diameter.
 - 4. Overall length shall consider insulation thickness.
 - 5. Thermowell shall be utilized on all process piping and vessels to allow for the removal without disturbing the process.
- B. Acceptable manufacturers:
 - 1. Rosemont 114C
 - 2. Yokagowa WH3
 - 3. Wika TW 15
 - 4. Or Equal.

2.2 RTDs

- A. All temperature sensors shall be PT 100 3 wire RTD type.
- B. The use of thermistors is not allowed.
- C. RTDs mounted in thermowells shall utilize thermal heat transfer paste.
- D. RTDs single point temperature sensors shall be:
 - 1. Platinum RTD type, with the following minimum performance.
 - 2. Accuracy: +/- 0.1% @ 32°F | +/- 0.25% @ 70°F | +/- 1.0% @ 266°F
 - 3. Operating Range: -40 to 275°F.
 - 4. Conformance: DIN-IEC 751 Class A.
 - 5. Sensor material: 316 stainless steel.
- E. Acceptable manufacturers:
 - 1. Pyromation RAF185L
 - 2. Temco RTD 00361
 - 3. Or Equal

2.3 TEMPERATURE TRANSMITTERS

- A. All temperature transmitters shall have 4-20 Ma output.
- B. All temperature transmitters shall Allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All temperature transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All temperature transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. Temperature transmitter shall have Input type that is selectable: Thermocouples, 2-, 3-, and 4-wire RTDs, ohms and DC millivolts.
- F. All Temperature transmitters shall have a configurable LCD digital display.
- G. LCD shall INCLUDE 5-digit numerical display with °C, K, °F, °R, % and mV, 0 to 100 % bargraph and dot- matrix display.
- H. Temperature transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- I. Temperature transmitter housings shall be stainless steel for exterior applications.
- J. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- K. Temperature transmitter housings for interior use shall be polyurethane resin baked finish.
- L. Acceptable manufacturers:
 - 1. Yokagowa: YTA-110-EA2DA2DN
 - 2. Rosemont: 3144PD1A1NAM5WR3
 - 3. PR Electronics: 7501A3A2A11

2.4 GAUGE PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have 4-20 Ma output.
- B. All pressure transmitters shall allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot- matrix display.

- G. Pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- H. Pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable manufacturers:
 - 1. Yokagowa: EJA530E-JBS4N-012EN/FF1/D1
 - 2. Rosemont: 2088G2S22A1M4DW
 - 3. Endress & Hauser: PMC71-ABC1P6GAAAA73
- L. Provide 316 stainless steel block and bleed valves for all gauge pressure transmitters.
- M. Acceptable manufacturers:
 - 1. Parker Model HLS2V
 - 2. Anderson Greenwood M25VIS-4M
 - 3. WE Anderson BBV0F

2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- B. All differential pressure transmitters shall allow remote communications (HART protocol)
- C. All differential pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All differential pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All differential pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot-matrix display.
- G. Differential pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy or SCS14A stainless steel (option, equivalent to SS316 cast stainless steel and ASTM CF-8M).
- H. Differential pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable Manufacturers:

1. Yokagowa EJA110E-JHS4G-8-12E (contractor to verify capsule measurement range during submittal process.)
 2. Rosemount 2051CD3A02A1AS5D4 (contractor to verify capsule measurement range during submittal process.)
 3. Endress &Hauser PMD75-ABC7H62VCAA (contractor to verify capsule measurement range during submittal process.)
- L. Provide 316 stainless steel three valve manifolds for all differential pressure transmitters.
- M. Acceptable manufacturers:
1. Parker Model HLS2V
 2. Anderson Greenwood M4TVIS-4 SSA2
 3. WE Anderson BBV-1F
 4. Swagelok SS-V3NBF8-FL.

2.6 MAGNETIC FLOW METERS

A. GENERAL REQUIREMENTS (magnetic flowmeters):

1. The meter shall measure flow rate with electrodes mounted in the flow stream.
2. The electrode seal shall not be in direct contact with the flowing medium to protect against electrode sealing failure.
3. The meter shall be available with an optional field replaceable electrode assembly in 1"–12" sizes permitting cleaning and maintenance of the electrodes without the need to remove the meter from the line.
4. A PFA Teflon liner shall be supplied which is injection molded in the meter body to insure liner integrity.
5. The liner shall have an embedded metal reinforcing grid for sizes 1" through 16" to protect against collapse in vacuum services and cuts due to abrasion.
6. Ground rings shall be included as standard to prevent liner damage during installation and for liner protection in abrasive slurries.
7. The flowtube shall be all welded construction, bolted assemblies are not permitted.
8. Meters shall conform to established ISO face to face standards and shall be available in both wafer and flanged style process connections.
9. The standard performance specification shall be 0.35% of reading with an optional high accuracy calibration rated at 0.2% of reading.

B. GENERAL REQUIREMENTS (magnetic flowmeter converter):

1. Shall be Remote mounted with factory supplied cables to flowtube.
2. Shall be microprocessor-based with Hart communication superimposed on the 4-20 mA line.
3. The converter shall excite the field coils using a dual frequency excitation technique utilizing a 75 Hz high frequency component for stable flow measurements in slurries and fast response time for short batch processes. Optionally a 165 Hz high frequency component shall be available for very high concentration slurries to ensure greater stability and quicker response.
4. The converter shall provide diagnostics to detect insulating coatings on the electrodes and provide an alarm function.

5. The converter shall permit the measurement of fluids with conductivities as low as 1 microS/cm.
6. The converter outputs shall include a 4-20 mADC signal, an open collector pulse output rated 30VDC, 200 mA, as well as outputs for high flow/low flow alarm, self-diagnostic fault indication, bi-directional flow indication, totalizer switch and a flow switch.
7. Shall include a 3-line LCD, backlit, full dot matrix display. The display shall be programmable to indicate various display possibilities, including a bar graph for flow rate indication and a graphical representation of the extent to which the electrodes may be coating. The display shall include infrared switches to permit programming through the glass without the need to open the enclosure cover.
8. Flow Converter to be AXF11. Provide factory supplied cable from flowtube to flow converter.

C. Acceptable Manufacturers:

1. Flowmeter and signal converter are to be the Yokogawa ADMAG AXF series (high accuracy series).
2. Rosemount Model 8750W series with remote flow converter (high accuracy model.)
3. Badger Meter M4000 series with remote flow converter.

2.7 LIGHTNING PROTECTION

- A. Provide surge suppression for all exterior mounted transmitters.
- B. Acceptable manufacturers:
 1. Bourns Series 1669-01/ 05.
 2. Phoenix Contact S-PT1-2PE-24DC.
 3. Factory installed Lighting protection furnished with instrument.

2.8 ELECTRICALLY ACTUATED VALVES.

- A. Furnish and install Electrically actuated ball valves size 1-1/2" or smaller where shown on plans or called out within the specifications for open close duty.
- B. Furnish and install Electrically actuated control valves sized as shown on plans or called out within the specifications for open-close and modulating duty.
- C. Ball valves under 2" shall be threaded stainless steel construction. Ball valves 2-1/2" or larger shall be flanged stainless steel construction.
- D. 1000 PSI working pressure.
- E. 3-piece swing out design for easy maintenance.
- F. Direct mounting valve per ISO5211.
- G. Full port for unrestricted flow.

- H. 316 stainless steel body, ball and stem.
- I. Blow out proof stem.
- J. RTFE ball seats extend cycle life.
- K. Triple RTFE/Viton stem seal design, live loaded.
- L. Provide V Port ball valve for all modulating control valves.
- M. Provide stellite seats on valves utilized for steam service.
- N. Acceptable manufacturers:
 - 1. Bray V-Control
 - 2. Dezurik VPB series.
 - 3. Valtorc VP series

2.9 ELECTRIC VALVE ACTUATORS.

- A. Furnish and install electrically operated valve actuators for all open close and modulating duty valves as shown on the P&ID drawings.
- B. Actuators shall be designed for valve operation to ensure proper function in accordance to EN 15714-2:2010 electric actuators for industrial valves - basic requirements. Depending on application actuators shall be designed for ON-OFF, short-time duty (S2-15min) respectively Class A and B according to EN 15714-2 or MODULATING, intermittent duty (S4-25%) respectively Class C with up to 1.200 starts per hour; no. of starts depending on actuator size and output speed.
- C. Actuator shall have a design life of 10.000 OPEN-CLOSE-OPEN cycles, each consisting of 30 turns per sense of rotation and must be suitable for operating in any mounting position. Actuator design must provide simple setting, testing, maintenance and repair.
- D. Actuator settings shall be performed non-intrusive via push-buttons at motor control without special tools or instruments (e.g., battery backed setting tool). Provide Local controls at actuator (local-off -remote and open close switches).
- E. Electrical connection of actuators to be multi pin plug and socket connector, allowing quick disconnection in case of maintenance or repair. In order to prevent loss of screws during commissioning or maintenance, all covers shall be fixed with captive screws. In order to minimize the amount of spare parts required, parts such as covers, plug and sockets, parts must be interchangeable throughout all model sizes.
- F. Torque-transmitting housings must be made of cast iron, except motor housing. No plastic parts of any type shall be used, except for electric / electronic components, operating knobs / levers, indicator mechanism and sealing elements as far as applicable.

- G. Depending on valve application, actuators shall be self-locking. Self-locking shall remain active if actuator is switched to hand-operation-mode. For non-self-locking actuators with high output speeds a mechanical anti-back drive device shall be provided attached to the actuator.
- H. Valve mounting dimensions shall be according to ISO 5210 with use of a plug sleeve connection adapting to valve shaft. For rising stem applications, actuator design must allow actuator removal from output drive without disturbing the valve function.
- I. Motors must be suitable for operating at 3 phase power supply voltage of 480Volt AC (+/- 10%), 60Hz or 115Volt (+/- 10%) and shall be specifically designed for valve-actuator operation, characterized by high starting torque, low stall torque and low inertia. Motors shall be totally enclosed non-ventilated type (TENV). Motor housings and covers to be made of sea water resistant aluminum. Motor-insulation must be in accordance with IEC 85 Class F (311° F). Motors must be protected by 1 or 3 thermal monitoring devices, which are embedded in motor windings. Motor connections shall be internal by means of plug and socket.
- J. Actuator motors must develop full torque when power is turned on. All motors shall be of high starting torque type to facilitate 'unseating' of the valve. Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.
- K. One actuator size (same outside dimensions) shall be available covering output speeds from 4 to 180 rpm for a given torque range, to avoid over sizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator output torque must be available at 90 % of nominal voltage.
- L. In order to enable proper sizing of applicable electric equipment, actuator supplier has to disclose current value at maximum setting torque. Actuator shall be capable of opening and closing the valve against full differential pressure (150 PSI) within specified time on valve data sheet.
- M. No battery backed limit sensing shall be used to avoid actuator malfunction in case of power failure. Actuators shall have a hall sensor principle based absolute encoder for limit sensing with a resolution of 3° or better. Actuator shall not be equipped with a battery.
- N. Torque sensing shall be of mechanical sliding worm principle with torque values independently settable for 'OPEN' and 'CLOSE' direction. No electronic torque sensing derived from motor current or piezo-electric torque sensing at worm shaft. Torque setting shall be possible for 40% to 100% of rated torque.
- O. Integral motor controls shall be microprocessor based and include mechanically and electrically interlocked reversing contactors for ON-OFF duty and solid-state contacts (thyristors) for MODULATING duty actuators.
- P. Local controls shall consist of motor controls, push buttons OPEN-STOP-CLOSE-RESET, lockable selector switch LOCAL-OFF-REMOTE. Local controls shall be electrically attached to actuator via plug and socket connection. It shall be possible to re-position local controls at every 90°, so that push buttons and indication lights will face the operator.
- Q. In case actuators have to be mounted in difficult to access positions, it shall be possible to separate local controls (including motor controls) from actuator. A wall bracket shall be available to mount local controls / motor controls near valve actuator for distances up to 50 m cable length.

- R. Depending on detailed project design, actuator version shall be as follows:
1. ON-OFF, short-time duty S2-15 min with hard wired signals OPEN-STOP-CLOSE inputs to the PLC.
 2. MODULATING, intermittent duty S4-25% with hard wired communication via 4-20mA input signal, including a 4-20mA output signal, internally powered. Detailed wiring diagram to be supplied with submittal documents.
- S. Detailed wiring diagram shall show all relevant signals such as valve position, end positions (OPEN/CLOSE), selector switch position and high torque alarm in OPEN/CLOSE direction. In addition to this, actuator must provide a dedicated fault signal if there is a phase failure, motor protection tripped and/or high torque in OPEN/CLOSE direction or if hand wheel is engaged.
- T. All control signals, communication signals as well as main power supply must be wired to a multi pin plug and socket for customer connection. Terminal compartment shall provide sufficient space to accommodate the possible maximum number of incoming wires. A minimum of three cable entries must be provided for motor power cable and digital/ analogue inputs and outputs. Each cable entry shall be properly sealed by cable glands during site installation. Cable glands shall be chosen by contractor, responsible for wiring during commissioning phase.
- U. Each actuator shall provide an adequately sized internal and external connection for grounding.
- V. In order to prevent condensation, a heater must be installed inside the actuator, suitable for continuous operation. Actuator must provide an alarm signal in case of failure of anti-condensation heater.
- W. Protection class of actuator, including motor, shall be IP 68, according to EN 60529 against submersion up to 8 m head of water for at least 96 hours. During submersion it must be possible to operate the actuator at least 10 times.
- X. Actuators must be equipped with a hand wheel for manual operation. Clockwise operation of hand wheel shall cause clockwise movement of output drive. Hand wheel shall be clearly marked with an arrow and the word 'CLOSE'.
- Y. Hand wheel engagement shall be of spring-loaded push mechanism type and required manual declutching. Actuator must provide a switch signal when in manual mode.
- Z. Under manual operation, hand wheel shall drive the worm shaft. Self-locking shall be maintained in hand operation. Motor must be disengaged during manual operation. Hand wheel shall automatically disengage when the electric motor is energized.
- AA. Hand wheel must be sized allowing easy manual operation of output drive. The over torque indication shall be active in manual operation as well as motor operation, thus allowing a signal to be provided when the set-torque has been reached.
- BB. Bearings shall be of antifriction or self-lubricating type. Bearings shall not require any maintenance between general overhauls. Power gears shall be made from heat treated steel. Worm-wheels shall be made of bronze material. Actuator gear housing shall be filled with an adequate quantity of lubricant. Re-lubrication between general overhauls shall not be required.
- CC. Actuator corrosion protection shall fulfill the requirements of EN ISO 12944-2, classification of environments C4 with a specified salt spray test of 720h. Actuator painting must be performed

in such a way, that no corrosion takes place under ambient conditions as specified. All outside screws or bolts shall be made of stainless steel (A2). Actuators shall be corrosion protected with a primer coating and a two-layer powder coating consisting of an epoxy coating and a polyurethane top coating with a total film thickness of at least 140µm. Final color shall be manufacturers standard colors.

DD. Each actuator shall be factory tested. Tests shall be performed in accordance with IEC standards as far as applicable. A final inspection record shall be supplied with each actuator showing general actuator data, nominal current, no load current, starting current, power factor at rated torque, output speed, torque setting, limit setting (turns/stroke), high voltage test, functional test (including all options) and visual test.

EE. Acceptable manufacturers:

1. Rotork CMQ part turn actuators.
2. Hayward HRCD3 Series.
3. AUMA SQ actuators.
4. Limitorque LTQ 0034 series electric actuators with IP 68 housing.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART - 25 00 10 70 – INSTRUMENTATION

SECTION 25 00 20 - AIR HANDLERS CONTROL SYSTEM

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Section includes the general requirements for the Integrated Automation systems. Integrated Automation Systems are utilized on Production equipment and systems, chiller and boiler plants, scrap processing and dust collection systems, electrical substations, HVAC equipment, pollution control equipment, air, water (domestic hot and chilled), steam and natural gas systems.
- B. RELATED DIVISIONS AND SECTIONS
 - 1. All project sections within Division 01 – General Requirements
 - 2. Section 23 05 00 - Basic Mechanical Materials and Methods
 - 3. Section 23 05 53 - Identification for Mechanical Piping Ductwork and Equipment
 - 4. Section 23 31 13 – Ducts and Duct Accessories
 - 5. Section 23 34 16 – Fans
 - 6. Section 23 73 13 13- Indoor Basic Air Handling Units
 - 7. Section 23 73 13 – Air Rotation Units
 - 8. Section 23 73 43 19 – Outdoor Custom Air Handling Units
 - 9. All project sections within Division 25 – Integrated Automation
 - 10. All project sections within Division 26 – Electrical
- C. Where architectural features govern location of work, refer to architectural drawings and coordinate with other trades.

1.2 REFERENCES

- A. This section includes any rules and regulations of Federal, State, local authorities, and utility companies in force at the time of execution of contract.
- B. Agencies or publications referenced herein refer to the following:
 - 1. ADA: Americans with Disabilities Act
 - 2. ANSI: American National Standards Institute
 - 3. ASHRAE: American Society for Heating, Refrigeration, Air-Conditioning Engineers
 - 4. ASTM: American Society for Testing and Materials
 - 5. BICSI: Building Industry Consulting Services International
 - 6. EIA: Electronic Industries Association
 - 7. FCC: Federal Communications Commission
 - 8. ICEA: Insulated Cable Engineers Association
 - 9. IEEE: Institute of Electrical & Electronics Engineers
 - 10. ISO: International Organization for Standards
 - 11. NEC: National Electrical Code (2020)
 - 12. NECA: National Electrical Contractors Association
 - 13. NEMA: National Electrical Manufacturers Association
 - 14. NETA: National Electrical Testing Association
 - 15. NIST: National Institute of Standards & Technology

- 16. OSHA: Occupational Safety and Health Administration
- 17. TIA: Telecommunications Industries Association
- 18. UL: Underwriters Laboratories, Inc.

1.3 DEFINITIONS

- A. AHU: Air Handling Unit.
- B. ATC: Automatic Temperature Control.
- C. ATU: Air terminal Unit.
- D. AWG: American Wire Gauge (standard wire size measurement).
- E. BAS/BMS: Building Automation System/Building Management System.
- F. Device: Intelligent controller or other automated monitoring piece of equipment
- G. CD: Compact Disc used for data storage.
- H. Commissioning: Process to ensure installation and functionality is per design.
- I. Enterprise: Top level of integrated systems for overall logistical monitoring and business planning.
- J. EMS: Enterprise Management System.
- K. FCU: Fan Coil Unit.
- L. PLC: Programmable Logic Controller.
- M. I/O: Hardware inputs and outputs.
- N. Instrument: Device used to sense inputs or control outputs or both.
- O. Integration: Connection of disparate systems to a common platform using communication protocols.
- P. IP Address: Internet Protocol node address.
- Q. IT: Information Technologies.
- R. O&M: Operation & Maintenance Manuals.
- S. Object: Hardware or Software component such as a device or point.
- T. Point: Single hardware input/output or software data objects such as set points and attributes.
- U. Point list: List of inputs, outputs and parameters for specific systems.
- V. RFI: Request for Interpretation.

- W. Stand-Alone: the ability to function upon loss of communication.

1.4 SYSTEM DESCRIPTION

- A. The Air Handler control system includes integration, control and monitoring HVAC air handlers' systems the facility including;
1. Chillers including integration to PLC control system.
 2. AHU 1 through 4 that supplies the clean room area.
 3. AHU-5 that supplies the large format press room.
 4. FC-1 that supplies the third-floor office area.
 5. AHU-6 that supplies the second floor.
 6. ARU-1 , AR-2, AR-3 that supply the basement.
 7. All control dampers as shown on the P&ID drawings.
 8. All instrumentation and accessory hardware shown on the P&ID drawings.
 9. All variable frequency drives and control panels as shown on the P&ID drawings.
 10. All PLC hardware and control panels as detailed in the specifications.
 11. All electrically operated valves as shown on the P&ID drawings.
 12. All modulating control valves as shown in the P&ID drawings.
 13. Local operator interface terminals required for local control and monitoring.

1.5 CONTRACTOR REQUIREMENTS

- A. Air Handler control systems includes but is not limited to labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, network termination to GPO supplied network hardware, integration equipment, instrumentation and controls and integrated automated systems. The contractor is required to provide the following:
1. Procurement and installation of integrated automated systems hardware.
 2. Procurement and installation of automation systems SCADA software if specified in other sections.
 3. Integration of equipment systems with the automation systems SCADA software. This includes equipment supplied by others as shown in contract drawings.
 4. Provide the following PLC control systems for each air handler.
 - a. PLC AHU-1, AHU-2, AHU-3, AHU-4 (Clean room)
 - b. PLC-AHU-5/ FCU-1 (Third floor press room and FCU-1)
 - c. PLC-AHU-6, AHU-7 (Second floor)
 - d. PLC-ARU-1, ARU-2, ARU-3 (Basement).
 5. Procurement of ancillary equipment installed by others. This includes but is not limited to: labor and materials for terminations, pathways, installations, certifications, testing, system verification, project commissioning, instrumentation and controls and integrated automated systems.
 6. Controls contractor is required to furnish and install the following, and is responsible for the equipment and software as shown below as well as the contract documents;
 - a. PLC control cabinets completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.

- b. VFD control panels completely wired and tested before shipment. Main power feeds by electrical contractor. Field wiring by controls contractor or electrical contractor under the supervision of the controls contractor.
- c. Field mounted line or load reactors or harmonic filters for VFD's
- d. All control valves and actuators with position feedback Valves shown in the specs and on the contract drawings. Valves installed by piping contractor.
- e. All temperature and humidity sensors shown in the specs and on the contract drawings. Provide all mounting accessories and thermowells for pipe mounting of temperature transmitters and humidity sensors.
- f. All magnetic flowmeters. Installed by piping contractor.
- g. Differential pressure transmitters. To be installed by piping contractor.
- h. Filter Differential pressure transmitters.
- i. Pressure transmitters as specified or as shown on contract drawings. Provide block and bleed valves for all pressure transmitters.
- j. Any PLC and VFD panel supplemental air conditioners that may be shipped loose and field installed by the contractor.
- k. Computer equipment mounted in control panels as shown on contract drawings, or as specified in other sections.
- l. SCADA software as shown on contract drawings or as specified in other sections.
- m. Computer Servers and workstations as shown on the contract drawings or as specified in other sections.
- n. UPS systems as shown on the contract drawings.
- o. Any owner supplied equipment as specified in the contract documents.
- p. All Ethernet cabling from GPO supplied network equipment. Contractor will coordinate with owner on cable labeling requirements.

1.6 SUBMITTALS

- A. Contractor is to submit a complete schedule of submissions before submittal process.
- B. Submit each section independent and separate from other sections. For each product submission: contractor is to provide specification section and product number.
- C. Include only products within referenced specification section submission.
- D. Product Data: For each product submission, include the following:
 - 1. Table of contents for each submission.
 - 2. Submit each section independent and separate from other sections. Include only products within referenced specification section submission.
 - 3. Product data sheets for all required components and accessories.
 - 4. Submit manufactures checklist & calibration documentation for calibrated instrumentation.
 - 5. Identify actual product model number used for each drawing.
 - 6. Identify any proposed modifications to system design. (Specifications or Drawings)
 - 7. Organize product data based on specification Section, Part, and Article.
 - 8. A paragraph-by-paragraph specification compliance report indicating compliance for each numbered paragraph. The following format shall be used in completing the compliance report:
 - 9. Comply—without exception.
 - 10. Qualify—meet the functional intent. For each paragraph, the contractor shall identify all differences in specific functions stated in the given paragraph and provide a description of what is excluded or how the qualifying system will meet the function specified.

11. Does not comply—cannot meet specified function.
- E. Integration Plan: Network architecture and communications concepts/diagrams. Network architecture includes but is not limited to:
1. Nodes.
 2. Switches, include GPO furnished network hardware.
 3. Integrated systems and/or sub-systems.
 4. Dedicated I/O locations.
 5. Non Ethernet communications cabling.
 6. Coordination submission. Include an integration matrix detailing systems and protocols to be used. This includes equipment such as chiller, RO water systems, boilers and humidification systems.
 7. Workflow processes to integrate systems.
 8. Include communication hardware (gateways), software, and protocols to implement full systems integration.
 9. Identify proposed enhancements or deviations from project documents. Include specific drawings or specifications impacted.
 10. Provide coordination efforts to accommodate complete integration of systems including:
 - a. Vendor protocol requirements.
 - b. Vendor point list.
 - c. Submit PLC ladder logic for review.
 - d. Submit maintenance schedules for all controller, valves, dampers, and instrumentation.
 - e. Complete set of control and wiring diagrams. Include panel layout drawings if not shown on contract drawings.
- F. Start-up Plan:
1. Provide complete start up plan.
 2. Coordination of equipment controlled and monitored.
 3. Workflow process to start equipment.
 4. Equipment start-up requirements.
 5. Checklist.
 6. Intended sequence of work items.
 7. Start dates of individual work items.
 8. Duration of individual work items.
 9. Planned delivery dates for major material and equipment, and expected lead times.
 10. Milestones indicating possible restraints on work by other trades or situations.
 11. Coordinate equipment startup to coincide with construction schedules.
 12. Provide multiple startup and commissioning trips at no additional cost to owner to allow for phased startup of the mechanical systems.
- G. Owner Instruction and Training Plan:
1. Provide 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.
- h. Recommended classroom training and schedule.

H. Record Documents:

- 1. Include field condition updates.
- 2. Document material, make and model numbers where appropriate.
- 3. Update details, schedules, risers, etc.
- 4. I/O point as-built drawings.
- 5. Sequence details, modifications, or updates.
- 6. Control loops including final set-points and parameters.
- 7. Mark and detail on coordination drawings, exact locations of equipment installed.
- 8. Panel details for each unique panel.
- 9. PLC program backups.
- 10. Operator interface screen program backups.
- 11. SCADA application program backups.
- 12. All passwords and security configuration for all hardware and software.
- 13. All configuration and programming software for all controls as specified by owner and contract documents.

I. O&M Manuals:

- 1. O&M manuals for all equipment supplied under this contract. Include complete parts lists and bill of materials for PLC control panels and VFD panels.
- 2. At minimum, submit two electronic copies and four hard copies.
- 3. Do not include previously submitted product data.
- 4. Include a table of contents.
- 5. Tab manual based on specification chapters or sections.
- 6. Network architecture and communications concepts/diagrams.
- 7. Uploading and downloading software to the field hardware.
- 8. Finely detailed descriptions of all software programs.
- 9. Complete set of software engineering manuals.
- 10. Complete system design and engineering manual same as used by manufactures personnel.
- 11. Application Programming.
- 12. CD of any configuration tools used in project.
- 13. Operator instructions or User Manual.
- 14. Calibration and/or verification sheets for all instrumentation including but not limited to:
 - a. Liquid Flow Meters.
 - b. Air or gas Flow Meters.
 - c. CO2 Sensors.
 - d. Temperature Sensors.
 - e. Humidity Sensors.
 - f. Pressure transmitters.
 - g. Differential pressure transmitters.
 - h. Airflow monitoring stations.

J. Project Maintenance Manuals:

- 1. Include a table of contents.

2. 1 copy on CD three hard copies.
3. Organize by manual by specification section number.
4. Index sheet listing contents in alphabetical order.
5. Include the following:
 - a. Installation instructions
 - b. Manufacturer's operating and maintenance instructions (not product submittals)
 - c. Factory and field-test records, including calibration and factory setup
 - d. Printout of application control programs, one electronic copy and 2 hard copies.
 - e. Snapshot printout of each system installed
 - f. Signed checklist of each system showing complete I/O checkout and system commissioning.
 - g. Training schedule and course description catalog
 - h. Archived backup of software, drawings, and record documents
 - i. Installation contractor and service representative information
 - j. Licensing and warranty information including provided software
 - k. Documentation verifying all software licenses have been transferred to GPO.

K. Submit a User Workstation Planning Session Plan for each subject:

1. Graphics Generation.
2. Tag naming.
3. Alarm management.
4. Report Configuration.

1.7 QUALITY ASSURANCE

- A. All systems, equipment, components, accessories, and installation hardware must be new, free from defects, and currently in production.
- B. All work shall be compliant with applicable national and local codes.
- C. Demonstrate project compliance to Engineers satisfaction including construction and integration.
- D. Provide the same manufacturer components of a given type product throughout project.
- E. Support future compatibility for no less than 15 years with the ability to upgrade existing field panels and extend new field panels on an installed network.
- F. Digital equipment furnished under this contract shall have been tested and made to comply with limits of Class A computing device pursuant to Subpart J of Part 15 of FCC Rules.
- G. Maintain NEC workspace clearances:
 1. Install and operationally check systems utilizing factory-trained competent technicians skilled in the setting and adjustment of equipment used in this project.
- H. Test, adjust, and calibrate all end instruments before startup and commissioning.

- I. Follow project communication protocol for all correspondence. Any changes, decisions, etc. must be properly documented. The Engineer will not issue verbal directions. Verbal interpretations, clarifications, conversations, etc. are non-binding without proper documentation.
- J. Request for Interpretation (RFI) shall include:
 - 1. Referenced drawing and/or Specification Section number.
 - 2. Single request per RFI
 - 3. Single proposed solution per RFI
 - 4. Attached sketch of solution (if applicable)
 - 5. Attached specification verbiage (if applicable)
 - 6. Incomplete RFI's will be returned without response.
 - 7. Contact person.
- K. RFI answers are for clarification only and do not authorize additional work or change orders.
- L. Install devices in appropriate enclosure and in an accessible location.
- M. Install systems and devices in a neat, workmanlike manner and in accordance with manufacturer's recommendations.
- N. Continually monitor the field installation for code compliance and quality workmanship.
- O. Remove and re-install any systems or devices where installation is deemed of poor quality by Owner or Engineer.
- P. Provide software and firmware updates prior to and within 2 months of substantial completion.
- Q. Lead the coordination effort to ensure integration of various systems prior to installation.
- R. Comply with all health and safety regulations.
- S. Include automatic restart logic for loss of power, safeties, fire alarm shutdown, etc.
- T. Provide components not specifically indicated or specified, but necessary to make system function within the intent of contract documents.
- U. All electrical products to be listed and labeled by UL and comply with NEMA Standards.
- V. Provide a competent and experienced Project Manager.
- W. Engineering services shall be performed by factory-trained engineers.
- X. System shall be installed by factory trained mechanical and electrical installers either in direct employ of this Contractor or by subcontractors who are under direct supervision of this Contractor.
- Y. Use only manufacturer trained technicians who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided under this section.
- Z. Coordinate with the Owner to ensure that the control system will perform on the Owner's network environment without disruption to any of the other activities taking place on that LAN.

PART 2 PRODUCTS

2.1 GENERAL CONTROL PRODUCTS

- A. GPO has standardized on Allen Bradley Controls as the basis for all building monitoring and production control systems. GPO has standardized on Inductive Automation Ignition software for HMI Visualization and monitoring software. GPO has invested significant capital in training, software and support agreements; therefore, the use of alternate equipment and software is not permitted.
- B. All control systems shall be based upon the Allen Bradley Control Logix platform. This includes all equipment and systems detailed in section 1.4.
- C. Allen Bradley Control hardware:
- D. The processors shall be Control Logix 5580 series processors.
 - 1. Provide a minimum of 2 spare slots in each rack or 20% spare rack space for each I/O rack.
 - 2. Provide 1756-PA75 series power supplies for common spare parts inventory.
 - 3. Analog input modules shall be 1756-IF16. Modules shall be configured for single ended current mode. Provide 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 4. Analog output modules shall be 1756-OF8. Module shall be configured for current output mode. 1492-AIFM8-3 interface module and pre wired factory assembled cable.
 - 5. Digital input modules shall be 1756-IA16 or 1756-IB16. Provide 1492-IFM20 interface module and pre wired factory assembled cable.
 - 6. Digital output modules shall be 1756-OA16. Provide 1492-XIM20120-16R Relay interface module and pre-wired factory assembled cable.
 - 7. Provide din rail mounted signal conditioners to provide isolation for analog inputs from field devices that are powered from separate DC supply or self powered.
 - 8. 24VDC DC power supplies shall be equivalent to Allen Bradley 1606-XL240E. Power supply shall have a mean time between failure (MTBF) of 1,058,000 hours at 24VDC and 10 amps (full load). All power supplies shall be UL listed. Substitute power supplies shall be shall only be provided with the GPO approval during shop drawing review.
 - 9. Miniature circuit breakers shall be one, two or three pole design. UL 489 listed.
 - a. Dual rated for AC or DC applications.
 - b. DIN rail mounted miniature circuit breakers up to 63 amp current rating.
 - c. Current limiting design to provide fast short circuit interruption. that reduces the
 - d. Suitable for reverse feed applications
 - e. Suitable for branch circuit device
 - f. Fulfills UL 489, CSA C22.2 No.5 as well as IEC 60947-2 Standards.
 - g. Thermal-magnetic overcurrent protection
 - h. Three levels of short circuit protection, categorized by B, C and D curves.
 - i. SWD (switching duty) rated circuit protection.
 - j. Size breakers and trip curve in accordance with UL 508A.
 - k. Circuit breakers are not allowed on motor loads with the exception of electrically operated valves and dampers. All other motor loads will be protected with class J fuses.

10. Terminal blocks shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated at a minimum of 30 amps at 600 Volts and shall accommodate wire sizes of 24 to 10 AWG.
11. Terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 volt and shall accommodate wire sizes of 14 to 1/0 AWG.
12. Grounding terminal blocks shall be green/ yellow in color din rail mountable and UL listed. Grounding terminal blocks shall be rated at a minimum of 35 amps at 600 volts and shall accommodate wire sizes of 26 to 10 AWG.
13. Grounding terminal blocks for wires larger than 12 AWG shall be screw type, din rail mountable and UL listed. Terminal blocks shall be rated for 130 Amps at 600 Volts and shall accommodate wire sizes of 14 to 1/0 AWG.
14. All terminal blocks shall have a short circuit rating of no less than 100KA per UL 508A.
15. Terminal blocks and other panel components shall be mounted on din rail. Din rail shall be 1.38" x .30". Zinc-Plated Clear Chromated Steel and be UL listed.
16. I/O interface modules shall be mounted on elevated din rail. Elevated din rail shall be Symmetrical Rail 1.38" x .30" 2.26". high 3.28' long Copper-Free Aluminum and UL listed.
17. Push Buttons shall be 30 mm Allen Bradley 800H- series. No substitutions. Provide 2 NC –NO contact blocks for each operator. Button colors shall be green for start motor applications, red extended head for motor stop applications and black for general control functions. Provide other colors as determined by owner.
18. Selector switches shall be 1.18" Allen Bradley 800H series with standard operators. No substitutions Provide 1 NC-NO contact for each position.
19. Pilot lights shall be 1.18" Allen Bradley 800H series full voltage (12 to 130 Volt AC/DC) LED indicators. No substitutions. Provide color coded lenses for the following functions. Red indicates fault condition, Green indicates run or normal condition, blue indicates automatic mode, amber indicates manual or bypass mode. Provide color coded lenses as shown on contract drawings.
20. Provide all push buttons, selector switches and pilot lights with engraved legend plates. Plates shall be 2.25" x 2.25" square "automotive style" White with black letters. Legend plates shall be suitable for outdoor use. Emergency stop legend plates shall be yellow with black letters.

PART 3 EXECUTION INSTALLATION AND COMMISSIONING

3.1 DELIVERY, STORAGE, AND HANDLING

- A. Store products according to manufacturer's recommendations.
- B. Store products in original manufacturers packaging.
- C. All material shall be stored in a climate-controlled environment
- D. Do not store products more than 3 months prior to schedule installation.
- E. Coordinate deliveries of material with construction schedule and appropriate trades.

3.2 SCHEDULING

- A. Included in this project are connections to equipment provided by others. Coordinate deliveries, final locations, factory mounting, and various connections required.
- B. Coordinate activities with contract project schedule:
 - 1. Ensure integration activities are incorporated into project schedule.
 - 2. Communicate requirements to prevent potential damage from paint, dust, water, weather, etc.
 - 3. Monitor and take measures to assure protection for all equipment.
 - 4. Coordinate all IT requirements with owner and contract project schedule.

3.3 WARRANTY

- A. Submit warranty documentation upon completion of project or phase and acceptance by Engineer and Owner.
 - 1. Warranty start date shall be the date of substantial completion.
 - 2. Warranty period shall be 1 year on parts and labor and include 2 years of software upgrades.
- B. Repair or replace systems or parts found defective at no cost to Owner including: but not limited to:
 - 1. Operator workstation software, project-specific software, graphic software, database software, and firmware updates that resolve known software deficiencies as identified by the contractor shall be provided at no charge during the warranty period.
 - 2. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
 - 3. Include parts, labor, and necessary travel during warranty.
- C. Scheduled preventive maintenance (p.m.) visit twice a year during the warranty period to audit system performance.
 - 1. Each p.m. visit shall include exercising each control loop and control sequence for performance.
 - 2. A log of each loop tested and each control sequence verified shall be reviewed with the Owner.
- D. Provide vendor specific warranty information.
- E. Provide services incidental to proper performance.

3.4 SYSTEM STARTUP

- A. Start equipment according to manufactures recommendation.
- B. Document system start up time and date.
- C. Document person(s) performing startup.

- D. Coordinate startup with other trades.
- E. All equipment installation is to be complete before startup.

3.5 OWNER'S INSTRUCTIONS

- A. Provide a factory-trained instructor to give full instructions to designated personnel in the operation, maintenance, and programming of each piece of equipment or system. Instructors shall be thoroughly familiar with all aspects of the subject matter.
- B. The training shall be specifically oriented to the system and interfacing equipment installed.
- C. Include classroom instruction and field demonstration.
- D. Classroom instruction should include at a minimum:
 - 1. Detailed review of and as-built documentation and conditions.
 - 2. In depth discussion of theory or sequence of operations.
 - 3. Review organization and usability of O&M documentation.
 - 4. Maintenance procedures and schedules.
- E. Field instruction should include at a minimum:
 - 1. Normal maintenance procedures.
 - 2. Demonstration of operation.
 - 3. Demonstration of safeties and interlocks.

3.6 COMMISSIONING

- A. Participate in the commissioning process.
- B. Provide on-site programming support throughout the commissioning process to make program modifications as directed by the commissioning engineer.
- C. Provide documentation in final O&M package that reflects any changes made during the commissioning process.
- D. Provide necessary personnel during the commissioning process to test and validate all field devices and PLC I/O.
- E. Provide on-site start up support for each phase of equipment startup as well as final system commissioning.

END OF SECTION – 25 00 20 AIR HANDLERS CONTROL SYSTEM

SECTION 25 00 20 10 - LOCAL OPERATOR INTERFACE TOUCH SCREENS

PART 1 SEE SPECIFICATION 25 00 00 10 "LOCAL OPERATOR INTERFACE TOUCH SCREENS"
FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 10 "LOCAL OPERATOR INTERFACE TOUCH SCREENS"
FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 10 LOCAL OPERATOR INTERFACE TOUCH SCREENS

25 00 20 20 - VARIABLE-FREQUENCY MOTOR CONTROLLER

- PART 1 SEE SPECIFICATION 25 00 00 20 "VARIABLE-FREQUENCY MOTOR CONTROLLER" FOR CRITERIA.
- PART 2 SEE SPECIFICATION 25 00 00 20 "VARIABLE-FREQUENCY MOTOR CONTROLLER" FOR CRITERIA.
- PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 20 VARIABLE-FREQUENCY MOTOR CONTROLLER

25 00 20 30 - VARIABLE FREQUENCY DRIVE SYSTEMS

PART 1 SEE SPECIFICATION 25 00 00 30 "VARIABLE-FREQUENCY DRIVE SYSTEMS" FOR
CRITERIA.

END OF PART – 25 00 20 30 VARIABLE FREQUENCY DRIVE SYSTEMS

25 00 00 40 - FIELD EQUIPMENT CONTROL PANELS

PART 1 SEE SPECIFICATION 25 00 00 40 "FIELD EQUIPMENT CONTROL PANELS" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 40 "FIELD EQUIPMENT CONTROL PANELS" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 40 FIELD EQUIPMENT CONTROL PANELS

25 00 20 50 - IDENTIFICATION

PART 1 SEE SPECIFICATION 25 00 00 50 "IDENTIFICATION" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 50 "IDENTIFICATION" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 50 IDENTIFICATION

25 00 20 60 - CONDUCTORS AND CABLES

PART 1 SEE SPECIFICATION 25 00 00 60 "CONDUCTORS AND CABLES" FOR CRITERIA.

PART 2 SEE SPECIFICATION 25 00 00 60 "CONDUCTORS AND CABLES" FOR CRITERIA.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 60 CONDUCTORS AND CABLES

25 00 20 70 - INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes all instrumentation.

1.2 REFERENCES

- A. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- B. NFPA 92A - Smoke-Control Systems.
- C. NFPA 92B - Smoke Control Systems in Atria, Covered Malls, and Large Areas.
- D. UL-864/UUKL Smoke Control Listing
- E. UL 555/555S - Standard for Safety; Leakage Rated Dampers for Use in Smoke Control Systems.
- F. NFPA 70 National Electric Code.
- G. NFPA 79 Electrical Standard for Industrial Machinery.
- H. UL 508A Standards for Industrial Control Panels.
- I. UL 508 Standards for Industrial Equipment.
- J. ANSI: American National Standards Institute.
- K. API: American Petroleum Institute
- L. ASME: American Society of Mechanical Engineers
- M. ASTM: American Society for Testing and Materials (ASTM International)
- N. DIN: Deutsches Institut für Normung
- O. IEC: International Electrotechnical Commission.
- P. IEEE: Institute of Electrical and Electronics Engineers.
- Q. ISA: International Society of Automation formerly Instrument Society of America.
- R. ISO: International Organization for Standardization.
- S. FM: Factory Mutual Laboratories (FM Approved).

1.3 SYSTEM DESCRIPTION

- A. Meters, gauges and sensors for control and monitoring.
- B. Thermowells, Instrument Piping and Valves related to control and monitoring.
- C. Temperature and Pressure Switches.
- D. Power monitoring.
- E. Refrigerant monitoring.
- F. Control valves and electric actuators.
- G. Flow meters (air, water, steam and natural gas).
- H. Level sensors and transmitters.
- I. Temperature and Humidity Transmitters
- J. Lightning protection for instrumentation.

1.4 SUBMITTALS

- A. Submit installation plan including:
 - 1. Recommended modifications to design documents.
 - 2. Documentation for vendor specific limitations or modifications.
 - 3. Sequence of installation.
 - 4. Coordination requirements.
 - 5. Instrument cut sheets and manufacturers data.
 - 6. Complete Instrument model numbers.
 - 7. Installation manuals and instructions.
 - 8. Loop sheets for instrumentation.
- B. The catalog numbers in the specification are intended to guide the controls contractor in the selection of the instrumentation. It is the contractor's responsibility to provide the proper instrumentation for the chiller control system.

1.5 QUALITY ASSURANCE

- A. Coordinate timely delivery of materials.
 - 1. Coordinate installation activities of inline devices such as immersion wells, pressure tapping's, any associated shut-off valves, flow switches, level switches, flow meters, air flow stations with mechanical contractor.
 - 2. Coordinate with Mechanical and Electrical contractor on valves or equipment furnished by others but are to be integrated into the control system.

- B. Install all control devices in appropriate enclosure and in an accessible location.
- C. Provide junction box or enclosure to protect wiring and allow conduit connection for all sensors
- D. Mount duct instrumentation on top or side of horizontal ducts. Do not mount on bottom of duct.

PART 2 PRODUCTS

2.1 THERMOWELLS

- A. Provide all thermowells as part of instrumentation package:
 - 1. Thermowells shall be threaded 316 Stainless steel.
 - 2. Insertion length shall follow industry standards.
 - 3. Typically, insertion length shall be 1/3 the pipe diameter.
 - 4. Overall length shall consider insulation thickness.
 - 5. Thermowell shall be utilized on all process piping and vessels to allow for the removal without disturbing the process.
- B. Acceptable manufacturers:
 - 1. Rosemont 114C
 - 2. Yokagowa WH3
 - 3. Wika TW 15
 - 4. Or Equal.

2.2 RTDs

- A. All temperature sensors shall be PT 100 3 wire RTD type.
- B. The use of thermistors is not allowed.
- C. RTDs mounted in thermowells shall utilize thermal heat transfer paste.
- D. RTDs single point temperature sensors shall be:
 - 1. Platinum RTD type, with the following minimum performance.
 - 2. Accuracy: +/- 0.1% @ 32°F | +/- 0.25% @ 70°F | +/- 1.0% @ 266°F
 - 3. Operating Range: -40 to 275°F.
 - 4. Conformance: DIN-IEC 751 Class A.
 - 5. Sensor material: 316 stainless steel.
- E. Acceptable manufacturers:
 - 1. Pyromation RAF185L
 - 2. Temco RTD 00361
 - 3. Or Equal

2.3 TEMPERATURE TRANSMITTERS

- A. All temperature transmitters shall have 4-20 Ma output.
- B. All temperature transmitters shall Allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All temperature transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All temperature transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. Temperature transmitter shall have Input type that is selectable: Thermocouples, 2-, 3-, and 4-wire RTDs, ohms and DC millivolts.
- F. All Temperature transmitters shall have a configurable LCD digital display.
- G. LCD shall INCLUDE 5-digit numerical display with °C, K, °F, °R, % and mV, 0 to 100 % bargraph and dot- matrix display.
- H. Temperature transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- I. Temperature transmitter housings shall be stainless steel for exterior applications.
- J. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- K. Temperature transmitter housings for interior use shall be polyurethane resin baked finish.
- L. Acceptable manufacturers:
 - 1. Yokagowa: YTA-110-EA2DA2DN
 - 2. Rosemont: 3144PD1A1NAM5WR3
 - 3. PR Electronics: 7501A3A2A11

2.4 GAUGE PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have 4-20 Ma output.
- B. All pressure transmitters shall allow remote communications (HART protocol) via the 4-20 mA lines without disrupting meter output.
- C. All pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot- matrix display.

- G. Pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy.
- H. Pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable manufacturers:
 - 1. Yokagowa: EJA530E-JBS4N-012EN/FF1/D1
 - 2. Rosemont: 2088G2S22A1M4DW
 - 3. Endress & Hauser: PMC71-ABC1P6GAAAA73
- L. Provide 316 stainless steel block and bleed valves for all gauge pressure transmitters.
- M. Acceptable manufacturers:
 - 1. Parker Model HLS2V
 - 2. Anderson Greenwood M25VIS-4M
 - 3. WE Anderson BBV0F

2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- A. All pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- B. All differential pressure transmitters shall allow remote communications (HART protocol)
- C. All differential pressure transmitters shall have two wire 4 to 20 mA DC. Output range: 3.68 mA to 20.8 mA.
- D. All differential pressure transmitters shall have HART® protocol is superimposed on the 4 to 20 mA signal.
- E. All differential pressure transmitters shall have an LCD digital display.
- F. LCD display shall include 5-digit numerical display with a 0 to 100 % bargraph and dot-matrix display.
- G. Differential pressure transmitter housings shall be constructed of Low copper cast-aluminum alloy or SCS14A stainless steel (option, equivalent to SS316 cast stainless steel and ASTM CF-8M).
- H. Differential pressure transmitter housings shall be stainless steel for exterior applications.
- I. Transmitter housings shall be rated for IP66/IP67, NEMA 4X.
- J. Pressure transmitter housings for interior use shall be polyurethane resin baked finish.
- K. Acceptable Manufacturers:

1. Yokagowa EJA110E-JHS4G-8-12E (contractor to verify capsule measurement range during submittal process.)
 2. Rosemount 2051CD3A02A1AS5D4 (contractor to verify capsule measurement range during submittal process.)
 3. Endress &Hauser PMD75-ABC7H62VCAA (contractor to verify capsule measurement range during submittal process.)
- L. Provide 316 stainless steel three valve manifolds for all differential pressure transmitters.
- M. Acceptable manufacturers:
1. Parker Model HLS2V
 2. Anderson Greenwood M4TVIS-4 SSA2
 3. WE Anderson BBV-1F
 4. Swagelok SS-V3NBF8-FL.

2.6 FILTER DIFFERENTIAL PRESSURE TRANSMITTERS

- A. Differential pressure transmitters to be used for filter monitoring only. Use differential pressure transmitters specified in 2.5 for all other applications.
- B. Supply voltage 22-36 VDC.
- C. Output; 40-20 Ma @ 250 Ohms, 2 wire loop powered.
- D. Response Time (0-100% FSO): 4 seconds.
- E. Output Update Rate: 0.5 second intervals.
- F. Pressure Range: Contractor to verify range at time of submittal.
- G. Accuracy: +/-0.25% FSO.
- H. Zero Function: Pushbutton Zero Function.
- I. Provide digital display option.
- J. Operating Temperature Range: -4 to 185°F.
- K. Display units and output: Inches WC.
- L. Instrument shall be housed in a NEMA 4X non-metallic enclosure.
- M. Provide 5-year warranty.
- N. Provide NIST Certification: 3 Point NIST Test Points: 10%, 50%, & 90% FSO.
- O. Differential pressure transmitter shall be Automation Components DLP Series or approved equal.

2.7 MAGNETIC FLOW METERS

A. GENERAL REQUIREMENTS (magnetic flowmeters):

1. The meter shall measure flow rate with electrodes mounted in the flow stream.
2. The electrode seal shall not be in direct contact with the flowing medium to protect against electrode sealing failure.
3. The meter shall be available with an optional field replaceable electrode assembly in 1"–12" sizes permitting cleaning and maintenance of the electrodes without the need to remove the meter from the line.
4. A PFA Teflon liner shall be supplied which is injection molded in the meter body to insure liner integrity.
5. The liner shall have an embedded metal reinforcing grid for sizes 1" through 16" to protect against collapse in vacuum services and cuts due to abrasion.
6. Ground rings shall be included as standard to prevent liner damage during installation and for liner protection in abrasive slurries.
7. The flowtube shall be all welded construction, bolted assemblies are not permitted.
8. Meters shall conform to established ISO face to face standards and shall be available in both wafer and flanged style process connections.
9. The standard performance specification shall be 0.35% of reading with an optional high accuracy calibration rated at 0.2% of reading.

B. GENERAL REQUIREMENTS (magnetic flowmeter converter):

1. Shall be Remote mounted with factory supplied cables to flowtube.
2. Shall be microprocessor-based with Hart communication superimposed on the 4-20 mA line.
3. The converter shall excite the field coils using a dual frequency excitation technique utilizing a 75 Hz high frequency component for stable flow measurements in slurries and fast response time for short batch processes. Optionally a 165 Hz high frequency component shall be available for very high concentration slurries to ensure greater stability and quicker response.
4. The converter shall provide diagnostics to detect insulating coatings on the electrodes and provide an alarm function.
5. The converter shall permit the measurement of fluids with conductivities as low as 1 microS/cm.
6. The converter outputs shall include a 4-20 mADC signal, an open collector pulse output rated 30VDC, 200 mA, as well as outputs for high flow/low flow alarm, self-diagnostic fault indication, bi-directional flow indication, totalizer switch and a flow switch.
7. Shall include a 3-line LCD, backlit, full dot matrix display. The display shall be programmable to indicate various display possibilities, including a bar graph for flow rate indication and a graphical representation of the extent to which the electrodes may be coating. The display shall include infrared switches to permit programming through the glass without the need to open the enclosure cover.
8. Flow Converter to be AXF11. Provide factory supplied cable from flowtube to flow converter.

C. Acceptable Manufacturers:

1. Flowmeter and signal converter are to be the Yokogawa ADMAG AXF series (high accuracy series).
2. Rosemount Model 8750W series with remote flow converter (high accuracy model.)

3. Badger Meter M4000 series with remote flow converter.

2.8 DUCT AND SPACE MOUNTED TEMPERATURE AND HUMIDITY TRANSMITTERS

- A. Provide duct or wall mounted temperature and humidity transmitters for each measurement location as shown on the drawings and specifications.
- B. Wall or duct mounted transmitter shall incorporate a thin film polymer capacitive HUMICAP® humidity sensor that is field replaceable and have an accuracy of $\pm 1\%$ RH (0...90% RH) and $\pm 1.7\%$ RH (90...100% RH) at 59 ... +77 °F.
- C. Temperature sensor shall be a platinum 100 Ω RTD with an accuracy of $\pm 0.36^\circ\text{F}$ at 68°F.
- D. Electronics to be protected in a NEMA 4 enclosure.
- E. Transmitter to be powered by 10...35 VDC, 24 VAC or optional 100...240 VAC and provide two linear selectable analog outputs of: 4 to 20 mA, 0 to 20 mA, 0 to 1 V, 0 to 5 V, or 0 to 10 V, as well as serial output of standard RS232C (optional RS 485/422 or Ethernet).
- F. Transmitter shall also have the option for a third analog output if required.
- G. Transmitter shall operate over the 0 to 100% RH range and -40° to 140°F temperature range.
- H. Transmitter shall be microprocessor based giving the option to calculate and directly output dew point, frost point, absolute humidity, wet bulb temperature, mixing ratio, enthalpy, ppm (volume or weight), partial pressure of water vapor, and saturation vapor pressure.
- I. Transmitter shall incorporate a local graphical/numerical display in its cover.
- J. Display shall indicate Relative Humidity (0 to 100%), Temperature (-40° to 140°F) and dew point.
- K. Transmitter shall be able to be calibrated, without disturbing operation, using a single point electronic transfer standard.
- L. Provide NIST traceable calibration certificate for each instrument.
- M. Provide remote cable for all duct mounted sensors with sufficient length to allow transmitter to be mounted no more than 5 feet AFF.
- N. Vaisala Model HMT-331 series are to be utilized for all clean rooms, press rooms, manufacturing spaces, laboratories, production material storage areas, and data centers.
- O. Acceptable manufacturers:
 1. Vaisala Model HMT-331. No substitutions.

2.9 LIGHTNING PROTECTION

- A. Provide surge suppression for all exterior and roof top mounted transmitters.

B. Acceptable manufacturers:

1. Bourns Series 1669-01/ 05.
2. Phoenix Contact S-PT1-2PE-24DC.
3. Factory installed Lighting protection furnished with instrument.

2.10 ELECTRICALLY ACTUATED CONTROL VALVES

- A. Furnish and install electrically actuated flanged stainless-steel V port ball valves sized as shown on plans or called out within the specifications for modulating duty.
- B. Ball valves shall be available in from ½" to 8" with 150# ANSI flanges.
- C. Valve body shall be constructed of 301 stainless steel. Ball and stem shall be constructed of stainless steel.
- D. Valve construction shall be Seat: TFM Seal, TFM Washer, and Packing: TFM.
- E. Valve temperature limits shall be -50°F to 500°F.
- F. Ball shall be available in 60° and 90° and offer an equal percentage flow characteristic.
- G. Contractor is to submit CV calculations for every V port valve.
- H. V Port valve shall be bubble tight and zero leakage at 150 PSI.
- I. Maximum steam working pressure shall be 150 PSI saturated.
- J. Valves seats for steam service shall 316 stainless steel with stellite coating.
- K. Valves shall have ISO
- L. Acceptable manufacturers for V Port ball valves:
 1. FlowTek V Control series F15/F30.
 2. Val-Matic American-BFV.
 3. Valtorc Series VP-1000.

2.11 ELECTRIC VALVE ACTUATORS.

- A. Furnish and install electrically operated valve actuators for all open close and modulating duty valves as shown on the P&ID drawings.
- B. Actuators shall be designed for valve operation to ensure proper function in accordance to EN 15714-2:2010 electric actuators for industrial valves - basic requirements. Depending on application actuators shall be designed for ON-OFF, short-time duty (S2-15min) respectively Class A and B according to EN 15714-2 or MODULATING, intermittent duty (S4-25%) respectively Class C with up to 1.200 starts per hour; no. of starts depending on actuator size and output speed.

- C. Actuator shall have a design life of 10.000 OPEN-CLOSE-OPEN cycles, each consisting of 30 turns per sense of rotation and must be suitable for operating in any mounting position. Actuator design must provide simple setting, testing, maintenance and repair.
- D. Actuator settings shall be performed non-intrusive via push-buttons at motor control without special tools or instruments (e.g. battery backed setting tool). A wireless Bluetooth interface shall be available. Microsoft Windows based software running on a conventional computer shall be available to allow actuator set-up and diagnoses.
- E. Electrical connection of actuators to be multi pin plug and socket connector, allowing quick disconnection in case of maintenance or repair. In order to prevent loss of screws during commissioning or maintenance, all covers shall be fixed with captive screws. In order to minimize the amount of spare parts required, parts such as covers, plug and sockets, parts must be interchangeable throughout all model sizes.
- F. Torque-transmitting housings must be made of cast iron, except motor housing. No plastic parts of any type shall be used, except for electric / electronic components, operating knobs / levers, indicator mechanism and sealing elements as far as applicable.
- G. Depending on valve application, actuators shall be self-locking. Self-locking shall remain active if actuator is switched to hand-operation-mode. For non-self-locking actuators with high output speeds a mechanical anti-back drive device shall be provided attached to the actuator.
- H. Valve mounting dimensions shall be according to ISO 5210 with use of a plug sleeve connection adapting to valve shaft. For rising stem applications, actuator design must allow actuator removal from output drive without disturbing the valve function.
- I. Motors must be suitable for operating at 3 phase power supply voltage of 480Volt AC (+/- 10%), 60Hz or 115Volt (+/- 10%) and shall be specifically designed for valve-actuator operation, characterized by high starting torque, low stall torque and low inertia. Motors shall be totally enclosed non-ventilated type (TENV). Motor housings and covers to be made of sea water resistant aluminum. Motor-insulation must be in accordance with IEC 85 Class F (155° C). Motors must be protected by 1 or 3 thermal monitoring devices, which are embedded in motor windings. Motor connections shall be internal by means of plug and socket.
- J. Motors must be totally separated from lubricant-filled gearing of actuator, allowing replacement of motor without loss of lubricant regardless of mounting position. Motors shall have a dog coupling as mechanical connection to actuators worm shaft.
- K. Actuator motors must develop full torque when power is turned on. All motors shall be of high starting torque type to facilitate 'unseating' of the valve. Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.
- L. One actuator size (same outside dimensions) shall be available covering output speeds from 4 to 180 rpm for a given torque range, to avoid over sizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator output torque must be available at 90 % of nominal voltage.

- M. In order to enable proper sizing of applicable electric equipment, actuator supplier has to disclose current value at maximum setting torque. Actuator shall be capable of opening and closing the valve against full differential pressure (150 PSI) within specified time on valve data sheet.
- N. No battery backed limit sensing shall be used to avoid actuator malfunction in case of power failure. Actuators shall have a hall sensor principle based absolute encoder for limit sensing with a resolution of 3° or better. Actuator shall not be equipped with a battery.
- O. Torque sensing shall be of mechanical sliding worm principle with torque values independently settable for 'OPEN' and 'CLOSE' direction. No electronic torque sensing derived from motor current or piezo-electric torque sensing at worm shaft. Torque setting shall be possible for 40% to 100% of rated torque.
- P. Integral motor controls shall be microprocessor based and include mechanically and electrically interlocked reversing contactors for ON-OFF duty and solid-state contacts (thyristors) for MODULATING duty actuators.
- Q. Local controls shall consist of motor controls, push buttons OPEN-STOP-CLOSE-RESET, lockable selector switch LOCAL-OFF-REMOTE. Local controls shall be electrically attached to actuator via plug and socket connection. It shall be possible to re-position local controls at every 90°, so that push buttons and indication lights will face the operator.
- R. In case actuators have to be mounted in difficult to access positions, it shall be possible to separate local controls (including motor controls) from actuator. A wall bracket shall be available to mount local controls / motor controls near valve actuator for distances up to 50 m cable length.
- S. Depending on detailed project design, actuator version shall be as follows:
 - 1. ON-OFF, short-time duty S2-15 min with hard wired signals OPEN-STOP-CLOSE inputs to the PLC.
 - 2. MODULATING, intermittent duty S4-25% with hard wired communication via 4-20mA input signal, including a 4-20mA output signal, internally powered. Detailed wiring diagram to be supplied with submittal documents.
- T. Detailed wiring diagram shall show all relevant signals such as valve position, end positions (OPEN/CLOSE), selector switch position and high torque alarm in OPEN/CLOSE direction. In addition to this, actuator must provide a dedicated fault signal if there is a phase failure, motor protection tripped and/or high torque in OPEN/CLOSE direction or if hand wheel is engaged.
- U. All control signals, communication signals as well as main power supply must be wired to a multi pin plug and socket for customer connection. Terminal compartment shall provide sufficient space to accommodate the possible maximum number of incoming wires. A minimum of three cable entries must be provided for motor power cable and digital/ analogue inputs and outputs. Each cable entry shall be properly sealed by cable glands during site installation. Cable glands shall be chosen by contractor, responsible for wiring during commissioning phase.
- V. Each actuator shall provide an adequately sized internal and external connection for grounding.
- W. In order to prevent condensation, a heater must be installed inside the actuator, suitable for continuous operation. Actuator must provide an alarm signal in case of failure of anti-condensation heater.

- X. Protection class of actuator, including motor, shall be IP 68, according to EN 60529 against submersion up to 8 m head of water for at least 96 hours. During submersion it must be possible to operate the actuator at least 10 times.
- Y. Actuators must be equipped with a hand wheel for manual operation. Clockwise operation of hand wheel shall cause clockwise movement of output drive. Hand wheel shall be clearly marked with an arrow and the word 'CLOSE'.
- Z. Hand wheel engagement shall be of spring-loaded push mechanism type and required manual declutching. Actuator must provide a switch signal when in manual mode.
- AA. Under manual operation, hand wheel shall drive the worm shaft. Self-locking shall be maintained in hand operation. Motor must be disengaged during manual operation. Hand wheel shall automatically disengage when the electric motor is energized.
- BB. Hand wheel must be sized allowing easy manual operation of output drive. The over torque indication shall be active in manual operation as well as motor operation, thus allowing a signal to be provided when the set-torque has been reached.
- CC. Bearings shall be of antifriction or self-lubricating type. Bearings shall not require any maintenance between general overhauls. Power gears shall be made from heat treated steel. Worm-wheels shall be made of bronze material. Actuator gear housing shall be filled with an adequate quantity of lubricant. Re-lubrication between general overhauls shall not be required.
- DD. Two nameplates, made of aluminum, shall be attached to each actuator; one on the motor housing, showing all relevant motor data, one on the actuator housing showing all relevant actuator data. Special information, such as valve tag no., shall be shown if required. Nameplates shall be securely fixed to actuator and motor, so that they cannot be removed or scratched off during shipment, installation, operation or maintenance.
- EE. Actuator corrosion protection shall fulfill the requirements of EN ISO 12944-2, classification of environments C4 with a specified salt spray test of 720h. Actuator painting must be performed in such a way, that no corrosion takes place under ambient conditions as specified. All outside screws or bolts shall be made of stainless steel (A2). Actuators shall be corrosion protected with a primer coating and a two-layer powder coating consisting of an epoxy coating and a polyurethane top coating with a total film thickness of at least 140µm. Final color shall be manufacturers standard colors.
- FF. Each actuator shall be factory tested. Tests shall be performed in accordance with IEC standards as far as applicable. A final inspection record shall be supplied with each actuator showing general actuator data, nominal current, no load current, starting current, power factor at rated torque, output speed, torque setting, limit setting (turns/stroke), high voltage test, functional test (including all options) and visual test.
- GG. Supplier to provide storage- installation- and operation instruction as well as electric wiring diagram, dimensional drawings and technical data sheet including motor data as per manufacturer standard.
- HH. Provide worm gear boxes for larger butterfly valve to reduce the actuator torque required for proper valve operation. Electric actuators and gearboxes shall be supplied by the same manufacturer.

- II. Worm gearboxes shall be specifically designed for butterfly or ball valves and damper operation and shall meet the torque / lifetime requirements of EN 15714-2 (electric actuators for industrial valves – basic requirements).
- JJ. The gearboxes shall be self-locking.
- KK. The gearboxes shall have a worm wheel and worm shaft, including adjustable mechanical end stops.
- LL. For motor operation in modulating duty, the worm wheel shall generally be made of bronze.
- MM. If required, worm gearboxes shall be equipped with a primary planetary gearing to reduce input torque.
- NN. The gearbox housing shall be made of cast iron (GG). Aluminum housing material (torque transmitting parts) is not acceptable.
- OO. The gearbox housing shall be filled with grease to guarantee adequate lubrication in any mounting position and a long service life.
- PP. Special self-lubricating bearings shall be provided to accept radial forces on the worm shaft.
- QQ. A thrust bearing shall carry the resulting axial load.
- RR. For motor operation, the gearboxes should withstand actuator tripping torque.
- SS. Enclosure protection shall be at least IP68, according to EN 60529. Worm gearboxes shall be sealed by radial seals or O-rings.
- TT. The adjustable mechanical end stop shall be designed as travelling nut to protect the gearbox housing / valve stem from excessive force. The design shall guarantee a defined stop when reaching the end of travel (valve is closed). The end stop shall be equipped with safety wedge discs to guarantee a mechanical stop block principle.
- UU. The end stop design shall accept the input torques as axial forces within the worm shaft, the load not being transmitted to the gearbox output / valve stem.
- VV. Travel limitation with stop screws (end stop screws as used for segment or quadrant type) placed in the gearbox housing shall not be permitted, as protection against excessive torque cannot be guaranteed.
- WW. The mechanical end stop shall be easily adjustable during commissioning and maintenance work on site to guarantee proper seating of the valve during operation. Swing angle shall be set at OEM.
- XX. Acceptable manufacturers:
 - 1. Rotork CMQ part turn actuators for ball valves.
 - 2. AUMA SQ actuators for ball valves.
 - 3. Limitorque LTQ 0034 series electric actuators with IP 68 housing.

2.12 ROOF MOUNTED TEMPERATURE AND HUMIDITY TRANSMITTERS

- A. Provide roof mounted temperature and humidity transmitter for temperature, humidity and wet bulb temperature as shown on the P&ID drawings and as specified in the contract documents.
- B. Transmitter shall incorporate a thin film polymer capacitive HUMICAP® humidity sensor that is field replaceable and have an accuracy of $\pm 1\%$ RH (0...90% RH) and $\pm 1.7\%$ RH (90...100% RH) at 59 ... +77 °F.
- C. Temperature sensor shall be a platinum 100 Ω RTD with an accuracy of $\pm 0.36^\circ\text{F}$ at 68°F.
- D. Electronics to be protected in a NEMA 4 enclosure.
- E. Transmitter to be powered by 10...35 VDC, 24 VAC or optional 100...240 VAC and provide two linear selectable analog outputs of: 4 to 20 mA, 0 to 20 mA, 0 to 1 V, 0 to 5 V, or 0 to 10 V, as well as serial output of standard RS232C (optional RS 485/422 or Ethernet).
- F. Transmitter shall also have a third analog output for wet bulb temperature.
- G. Transmitter shall operate over the 0 to 100% RH range and -40° to 140°F temperature range.
- H. Transmitter shall be microprocessor based giving the option to calculate and directly output dew point, frost point, absolute humidity, wet bulb temperature, mixing ratio, enthalpy, ppm (volume or weight), partial pressure of water vapor, and saturation vapor pressure.
- I. Transmitter shall incorporate a local graphical/numerical display in its cover.
- J. Display shall indicate Relative Humidity (0 to 100%), Temperature (-40° to 140°F) and dew point.
- K. Transmitter shall be able to be calibrated, without disturbing operation, using a single point electronic transfer standard.
- L. Provide NIST traceable calibration certificate for each instrument.
- M. Combined Pressure, Humidity and Temperature Transmitter shall be Vaisala model PTU-307. Provide analog outputs for pressure, temperature, (wet bulb) and RH.
- N. Provide Vaisala Meteorological Installation Kit HMT-330MIK to enable PTU-337 to be installed outdoors to obtain reliable measurements for meteorological purposes.

2.13 DAMPER ACTUATORS OPEN CLOSE DUTY AND MODULATING DUTY

- A. Provide damper actuators as shown on the P&ID drawings and as called out in the contract documents.
- B. All dampers shall be sized per the manufactures data with a safety factor of 1.8 for direct mount actuators.

- C. All dampers utilizing linkages and crank arms the actuator shall be sized per the manufacturers data with a safety factor of 2.0.
- D. Contract to submit torque calculations as part of submittal process.
- E. Basic Drive Unit:
 - 1. Control drive shall have integrated electronics and be able to operate in ambient temperatures of -40°F. to 185°F.
 - 2. The drive shall be furnished with a 120 volt AC, single phase, 60 Hz, synchronous motor. Motor shall be capable of withstanding continuous modulating duty of 60 starts / stops per minute at a minimum, or a stall condition without overheating. Design of the motor shall be such that electrical and thermal overloads are not required.
 - 3. Motor bearings shall be maintenance-free. Motor shall be non-coasting with instant magnetic braking, and shall be self-locking and self-releasing without the use of a separate brake winding, mechanical brake or worm gear mechanism. Control drive shall be designed to stay in place upon loss of power and shall be capable of holding a load equal to at least 200% of the model's rated output. The drive motor shall be a TENV with Class H insulation.
 - 4. Stall torque shall be self-limiting, not exceeding two and one half times the rated torque; torque switches shall not be required. Drive shall operate CW or CCW on increasing signal, with timing of 90 seconds for full 100° rotation. Gear train shall have high efficiency spur gears constructed of heat-treated alloy steel or ductile iron only. Readily available gear modules shall provide for a range of torque and timing combinations within the drive's rated capacity, and shall be field-interchangeable. Drive train parts shall be lubricated with a premium, heavy-duty lithium-based lubricant. Control drives shall be able to operate in any mounting orientation.
 - 5. Two SPDT over-travel limit switches shall be provided for over-travel protection. In addition, the drive shall have two, auxiliary SPDT switches which are infinitely adjustable over the full range of travel. Switches shall be rated for 6 amps at 120 volts AC. Drive shall have integral mechanical stops capable of limiting travel of the drive and load, with or without the drive motor.
 - 6. A low-speed, disc-type motor Handwheel shall permit manual operation of the drive without electrical power and without a declutching mechanism.
 - 7. A five-position, drive-mounted electric hand switch shall be provided to permit local electrical operation of the unit for control adjustment or operation on loss of control signal. With the hand switch in AUTO mode, drives shall respond to control signals automatically.
 - 8. Enclosure shall be totally enclosed, cast, weatherproof, dust-tight, NEMA 4X construction. All field connections shall be made at one terminal compartment. Separate conduit entrances shall be available for power and control wiring.
- F. Modulating drive shall provide modulating control through an integral, digital control module which positions the drive in proportion to the mA range of the control input signal.
- G. The control module shall be capable of initiating shaft movement in steps down to 0.1°.
- H. Standard control features should include:
 - 1. Field-configurable, pre-determined action upon loss of input signal.
 - 2. Stall protection.
 - 3. Split signal operation for control of multiple drives.
 - 4. External position feedback signal.

- I. Drive shall be operated by direct AC control power either from an automatic controller or by manually operated switches, with continuous positioning capability over the range of operation. Drive shall be capable of starting and stopping instantaneously for high-resolution positioning.
- J. For non-modulating open-close operation, drive shall provide open / close operation to preset travel limits upon closure of an automatic controller or by a manually operated switch, and have a 0.1% position repeatability, with end-of-travel limits adjustable over the full range of travel of the drive.
- K. For modulating operation, the drive shall be equipped with a contactless position sensing device and be capable of providing an isolated feedback signal with a 4–20 mA or 1–5 V dc range. The sensing device shall have infinite resolution.
- L. Acceptable manufacturers:
 - 1. Harold Beck and Sons Group 11 actuators. For high torque and face and bypass dampers.
 - 2. Honeywell Herculine series 2002 electric actuators. For high torque and face and bypass dampers.
 - 3. Honeywell HercuLine 10260A actuators for low to medium torque dampers. Do not use on face and bypass dampers.

2.14 DUCT AND AHU MOUNTED AIR FLOW STATIONS.

- A. Provide duct mounted and AHU mounted as shown on the P&ID drawings and as called out in the contract documents.
- B. Provide one AFMS with temperature output and an integral airflow alarm for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.
- C. Each AFMS shall be provided with a remotely mounted microprocessor-based transmitter and one or more sensor probes depending on duct or coil size.
- D. Devices that have electronic signal processing components in the sensor probe are not acceptable.
- E. Airflow measurement shall determine the average actual airflow rate.
- F. Temperature measurement shall determine the velocity weighted average temperature (factory default) or the arithmetic average (field selection).
- G. Sensor prbes shall be constructed of 6063 extruded aluminum alloy tube or optional 316 stainless steel tubes.
- H. Provide stainless steel sensor probes for clean room air handlers.
- I. Sensor probe mounting brackets shall be constructed of 304 stainless steel.
- J. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper conductors.

- K. Each sensor node shall contain one hermetically sealed 'bead-in-glass' thermistor sensor and one high performance parylene-coated chip thermistor, in a structural sensor housing. The airflow rate and temperature shall be independently determined at each measurement node prior to averaging.
- L. Each preselected probe shall be adjustable insertion or stand-off bracket type, and choice of probes in lengths of 6, 8, or 16 in.
- M. The maximum number of independent sensor nodes/probe provided shall be 1 each x 2 probes total.
- N. Probe to transmitter cables shall be FEP jacketed, plenum rated CMP/CL2P and UL/cUL Listed, -67° to 392° F and UV tolerant. Cables shall include a terminal plug for connection to the remotely mounted transmitter. PVC jacketed cables or PVC insulated conductors are not acceptable with ducted sensor probes.
- O. An integral microprocessor-based transmitter shall be provided for each measurement location.
 - 1. All printed circuit board interconnects and test points shall be gold plated.
 - 2. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.
- P. All integrated circuitry shall be temperature rated as 'industrial-grade'. Submissions containing commercial-grade integrated circuitry are not acceptable.
- Q. The transmitter shall be capable of determining the average airflow rate and temperature at each of the sensor nodes in the array.
- R. The transmitter shall be capable of identifying an AFMS malfunction and ignore any sensor node that is in a fault condition.
- S. The transmitter shall be provided with one of the following:
 - 1. Two scalable, protected and field selectable analog output signals (0-5 / 1-5 VDC or 0-10 / 2-10 VDC, choose one), or:
 - 2. One non-isolated RS-485 network connection (field selectable BACnet MS/TP or Modbus RTU).
- T. One analog output shall be airflow (AO1), while the second output (AO2) shall be configurable as airflow (independent of AO1 for dual outputs), average temperature (default), adjustable airflow alarm or system alarm.
 - 1. When the alarm is active, the alarm condition shall be indicated on the LCD display.
 - 2. Alarm reset shall be manual or automatic.
 - 3. Alarm set points shall be adjustable by type, tolerance, delay, disable/enable, and analog signal indication for AO2.
- U. RS-485 network communications shall provide the average airflow rate, average temperature, HiLo airflow alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures.
- V. Each transmitter shall provide one dry contact relay with onboard jumper to drive a remote LED. The relay shall be rated for no less than 30 VDC or 24 VAC @ 3 amp max.

- W. The transmitter shall have a built-in field adjustment wizard for one- or two-point output adjustments to the factory calibration, when required.
- X. The transmitter shall be powered by 24 VAC (22.8 to 26.4 under load) @8 V-A.
- Y. The transmitter shall provide an integral LCD for the display of airflow, temperature and alarms; and a pushbutton user interface for configuration and diagnostics.
- Z. The transmitter shall be mounted in an environment protected from direct contact with water. The transmitter shall be mounted in an accessible location.
- AA. The transmitter shall independently process the airflow and temperature of each sensor node prior to averaging and output.
- BB. The transmitter shall use a "watchdog" timer circuit to ensure continuous operation in the event of brown-out and/or power failure.
- CC. Each sensor node shall be individually calibrated at 7 measurement points to NIST traceable airflow standards.
 - 1. Submissions for AMD approval shall include a copy of the actual NIST report of calibration for the reference standard used.
 - 2. Devices claiming NIST traceability to third party laboratories and not directly to NIST are not acceptable
 - 3. Devices calibrated against standards other than the NIST LDA or against NIST temperature standards only are not acceptable.
- DD. Each sensing node shall have a temperature accuracy of $\pm 0.36^{\circ}\text{ F}$ ($\pm 0.2^{\circ}\text{ C}$) over a range of -20° F to 160° F .
- EE. Minimum calibrated and operating temperature range for the sensor probes shall be -20° F to 160° F .
- FF. Operating temperature range for the transmitter shall be -20° F to 120° F .
- GG. Acceptable Manufacturers:
 - 1. EBTRON Advantage IV with GTx116e-P+ transmitter for duct mounted sensors.
 - 2. Fan Array sensors shall be EBTRON Advantage IV with GTx108e-F / An transmitter. Provide one sensor for each fan in the fan array.
 - 3. Accutrol IAQ-Tek 2000. Series for outside airflow monitoring.
 - 4. Accutrol VorTekG3 – VTFA Series for fan array airflow. Provide one sensor for each fan.
- HH. Provide 3 year warranty on all components and a one year labor warranty.

PART 3 SEE SPECIFICATION 25 00 00 XX "EXECUTION" FOR RELATED CRITERIA.

END OF PART – 25 00 20 70 INSTRUMENTATION

SECTION 26 00 50 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Common electrical installation requirements.

1.2 DESCRIPTION OF WORK

A. Requirements of this Section are applicable to work in Division 26.

B. Contract Documents

1. Contract drawings for electrical work are diagrammatic, intended to convey scope and general arrangement.
2. Refer questions involving document interpretation or discrepancies to Engineer for review and direction.
3. Correct faulty work due to resolving discrepancies without proper approval.
4. Specifications establish quality of materials, equipment, workmanship and methods of construction.
5. Follow drawings and specifications in laying out work. Consult other applicable contract drawings and specifications, become familiar with conditions affecting work.

C. Scope

1. Furnish and install the electrical work complete and ready for satisfactory service.

D. Definitions: The following are definitions of terms and expressions used in Divisions 26.

1. "Accessible" – Capable of being removed or exposed without damaging the building or structure or finish or not permanently closed in by other equipment or by the structure or finish of the building.
2. "Approve" - To permit use of material, equipment or methods conditional upon compliance with contract document requirements.
3. "Concealed" - Hidden from normal sight; includes work in crawl spaces, above ceilings, and in building shafts.
4. "Directed" - directed by Engineer.
5. "Equal, equivalent" - possessing the same performance qualities and characteristics and fulfilling the same utilitarian function.
6. "Exposed" - not concealed.
7. "Furnish" - Supply and deliver to project site, ready for unloading, unpacking, assembly, installation, and similar operations.
8. "Indicated" - indicated in Contract Documents.
9. "Install" - Operations at project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimensions, finishing, curing, protecting, cleaning and similar operations.
10. "Provide" - furnish and install, complete and ready for the intended use.

11. "Removable" - detachable from the structure or system without physical alteration of materials or equipment and without disturbance to other construction.
12. "Review" - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.3 QUALITY ASSURANCE

- A. Regulations: Comply with regulations of IBC, NFPA, state, county, and municipal building ordinances, and other applicable codes and regulations.
- B. Provide UL label on electric powered equipment or certification that equipment has been tested by a testing agency approved by the local authority as equivalent in safety to UL labeled equipment.
- C. Material and Equipment Requirements
 1. All materials and equipment shall be new and free from defects.
 2. Use products of one manufacturer where two or more items of same kind of equipment are required.
 3. For certain items of equipment, the specification and the project design are based upon the specified manufacturer's product. Other manufacturers' names are listed. Contractor may purchase, conditional upon meeting project requirements, equipment from the listed manufacturers.
 4. Only the manufacturer's equipment upon which the specification and the project design has been based, has been checked for this project. Check allocated space and structure for suitability of equipment of other listed manufacturers, including parts replacement and servicing.
- D. Workmanship
 1. Remove and replace, at no extra cost, work not in conformance with contract requirements.
 2. Coordinate with Other Trades
 - a. Coordinate work and cooperate with other trades to facilitate execution of work.
 - b. Give full cooperation and coordination with other trades and furnish information necessary to permit the work of all trades to be installed satisfactorily with the least possible interference or delay.
 - c. Furnish to other trades, as required, necessary templates, patterns, setting plans and shop details for the proper installation of the work and for the purpose of coordinating adjacent work.
 3. Accessible Equipment and Systems:
 - a. Consider all materials and equipment installations and coordinate with the work of other trades to ensure equipment or systems are accessible for operations, maintenance, repairs, and replacement.
 - b. Install materials and equipment, including but not limited to, supports and electrical conduit, to permit complete unobstructed access to panelboards, transformers, and other items requiring access for inspection, maintenance, and operations.

- c. Engineer will disapprove the installation of new equipment or materials which renders new or existing equipment inaccessible, and Contractor shall correct the Work.

1.4 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment as follows:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.
 - 4. So that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Penetration Firestopping."

1.5 SHOP DRAWINGS AND SUBMITTALS

- A. Refer to Division 01 for complete requirements.
- B. Submit all products for a single specification section as a complete submittal. All products specified within a division shall be included, otherwise submittal will be returned as incomplete.
- C. Clearly mark submittals to indicate actual intended products to be utilized. Marks may include highlighting, circling, boxing, checking, etc. Do not provide submittal data which lists multiple product's options and features without clearly indicating which data applies to the products intended to be used on project.
- D. Coordinate drawings and data before submitting and certify that provisions of the contract documents have been met.
- E. Call attention, in writing, to deviations from contract requirements.
- F. Do not fabricate, deliver to site, or install items requiring shop drawing review, until the review has been completed by the Engineer and the shop drawing has been marked to indicate "No Exception Taken" or "Make Corrections Noted."
- G. Use only final or corrected drawings and data for construction. This includes all Addendums, Architectural Supplemental Information (ASIs), and Change Bulletins.

- H. The Engineer's review of submittals shall not be construed as a complete check, but will indicate only that the general method of construction, materials, detailing and other information are satisfactory. Approval will not relieve the Contractor of the responsibility for any error which may exist, as the Contractor under the requirements of this contract is responsible for dimensions, the design of adequate connections and details, and the satisfactory construction of all work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounted items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.
- F. Conditions of Occupancy
 - 1. This building will be occupied during the life of this contract. Execute work in a manner to impose minimal interference with the normal functioning of the building and its occupants. When interference is unavoidable, schedule work 14 days in advance with the Owner.
 - 2. Make temporary connections where necessary to maintain uninterrupted electrical service.
 - 3. Provide adequate protection for the building, its contents, and occupants.
 - 4. Perform work as quietly as possible to avoid unnecessary disturbance. Unusual precaution may be necessary in the conduct of work in some areas to achieve satisfactory compliance.
 - 5. Coordinate with Owner to Perform work producing high noise levels, dust, or hazards to occupants in occupied during non-business hours of the facility.
 - 6. Comply with regulations of Owner pertaining to circulation, sanitation, and behavior of Contractor's personnel.

3.2 FIRESTOPPING

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Penetration Firestopping."

END OF SECTION 26 00 50

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper building wire.
 - 2. Connectors and splices.
- B. Related Requirements:

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Bare Conductor.
 - 2. Cerro Wire LLC.
 - 3. Encore Wire Corporation.
 - 4. General Cable; Prysmian Group North America.
 - 5. Okonite Company (The).
 - 6. Service Wire Co.
 - 7. Southwire Company, LLC.
 - 8. WESCO.
- C. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. 3M Electrical Products.
 2. ABB, Electrification Business.
 3. ILSCO.
 4. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group.
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 1. Material: Copper.
 2. Type: Two hole with long barrels.
 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. All Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. All Branch Circuits: Type THHN/THWN-2, single conductors in raceway.
- C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inch of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:

- 1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
- 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
 - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

- B. Cables will be considered defective if they do not pass tests and inspections.

- C. Prepare test and inspection reports to record the following:

- 1. Procedures used.
- 2. Results that comply with requirements.
- 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding hubs.
5. Grounding and bonding connectors.
6. Grounding and bonding busbars.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product indicated.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. General Characteristics: 600 V, THHN/THWN-2, copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

2.3 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. Source Limitations: Obtain products from single manufacturer.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 - 2. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

2.4 GROUNDING AND BONDING HUBS

- A. Description: Hubs with certified grounding or bonding locknut.
- B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

2.5 GROUNDING AND BONDING CONNECTORS

A. Source Limitations: Obtain products from single manufacturer.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.

2.6 GROUNDING AND BONDING BUSBARS

A. Description: Miscellaneous grounding and bonding device that serves as common connection for multiple grounding and bonding conductors.

B. Source Limitations: Obtain products from single manufacturer.

C. Performance Criteria:

1. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2. Listing Criteria:

- a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF BUSBARS

- A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

- A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
- B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
- C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
- D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
- E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
- F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.

3.4 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

3.5 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Conductors:
 - a. 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.
2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
3. Equipment Grounding:
 - a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

- c. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

END OF SECTION 26 05 26

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support, anchorage, and attachment components.
2. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
2. Include rated capacities and furnished specialties and accessories.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design hanger and support system.
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel or Stainless steel, Type 304 depending on location.
 - 3. Channel Width: Selected for applicable load criteria.
 - 4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 - 6. Toggle Bolts: Stainless steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 SELECTION

- A. Outdoors: Stainless steel hangers, supports, and hardware.
- B. Indoors in Chemical Feed Areas (Mechanical room near chemical system for cooling towers), around water softeners, and around RO System: Stainless steel hangers, supports, and hardware.
- C. Indoors in other areas: Galvanized steel hangers, supports, and hardware.
- D. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA NEIS 101
 - 2. NECA NEIS 102.
- E. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- F. Comply with requirements for raceways and boxes specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- G. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as scheduled in NECA NEIS 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size must be 1/4 inch in diameter.
- H. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT IMC and ERMC may be supported by openings through structure members, in accordance with 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 must be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69, or Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000 psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:
1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup:

1. 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.

- a. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

- #### B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33.13 - CONDUITS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S duct raceways and elbows.
2. Type ERMC-S duct raceways, elbows, couplings, and nipples.
3. Type FMC-S duct raceways.
4. Type LFMC-S duct raceways.
5. Fittings for conduit, tubing, and cable.
6. Electrically conductive corrosion-resistant compounds for threaded conduit.

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

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

1.2 DEFINITIONS

- A. Conduit: A structure containing one or more duct raceways.
- B. Duct Raceway: A single enclosed raceway for conductors or cable.
- C. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.

1.3 ACTION SUBMITTALS

- A. Product Data for all products.

PART 2 - PRODUCTS

2.1 TYPE EMT-S DUCT RACEWAYS AND ELBOWS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN FJMX; including UL 797.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL FJMX - Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; Atkore International.
 - b. Calconduit; Atkore International.
 - c. Emerson Electric Co., Automation Solutions.
 - d. Picoma; Zekelman Industries.
 - e. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
 - f. Topaz Lighting & Electric.
 - g. Western Tube; Zekelman Industries.
 - h. Wheatland Tube; Zekelman Industries.
2. Material: Steel.
3. Options:
 - a. Exterior Coating: Zinc.
 - b. Interior Coating: Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.2 TYPE ERMCS DUCT RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DYIX; including UL 6.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DYIX - Galvanized-Steel Electrical Rigid Metal Conduit (ERMCS-G), Elbows, Couplings, and Nipples:

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. Allied Tube & Conduit; Atkore International.
 - b. Calconduit; Atkore International.

- c. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - e. Patriot Aluminum Products, LLC.
 - f. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
 - g. Topaz Lighting & Electric.
 - h. Western Tube; Zekelman Industries.
 - i. Wheatland Tube; Zekelman Industries.
 - 2. Exterior Coating: Zinc.
 - 3. Options:
 - a. Interior Coating: Zinc.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- D. UL DYIX - PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples:
- 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. ABB, Electrification Business.
 - b. Bluesteel Services LLC.
 - c. Calbond; Atkore International.
 - d. KorKap; Robroy Industries.
 - e. Perma-Cote; Robroy Industries.
 - f. Plasti-Bond; Robroy Industries.
 - 2. Options:
 - a. Exterior Coating: PVC complying with NEMA RN 1.
 - b. Interior Coating: Zinc.
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - d. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - e. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

2.3 TYPE FMC-S DUCT RACEWAYS

A. Performance Criteria:

- 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 2. Listing Criteria: UL CCN DXUZ; including UL 1.

B. Source Quality Control:

- 1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
- 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXUZ - Steel Flexible Metal Conduit (FMC-S):

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. ABB, Electrification Business.
 - b. Anaconda Sealtite; Anamet Electrical, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Co.
 - e. Penn Aluminum Conduit & EMT; Penn Aluminum International LLC; Berkshire Hathaway.
 - f. Topaz Lighting & Electric.
2. Material: Steel.
3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.4 TYPE LFMC-S DUCT RACEWAYS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN DXHR; including UL 360.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL DXHR - Steel Liquidtight Flexible Metal Conduit (LFMC-S):

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. ABB, Electrification Business.
 - b. Anaconda Sealtite; Anamet Electrical, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Co.
2. Material: Steel.
3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).

2.5 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Source Quality Control:

1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.

C. UL EBMB - Duct Fittings for Hazardous (Classified) Locations:

1. Listing Criteria: UL CCN EBMB; including UL 1203.

D. UL DWTT - Fittings for Type ERM C Duct Raceways:

1. Listing Criteria: UL CCN DWTT; including UL 514B.
2. Options:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Raintight compression coupling with distinctive color gland nut.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

E. UL FKAV - Fittings for Type EMT Duct Raceways:

1. Listing Criteria: UL CCN FKAV; including UL 514B.
2. Options:
 - a. Material: Steel or Die cast.
 - b. Coupling Method: Raintight compression coupling with distinctive color gland nut.
 - c. Expansion and Deflection Fittings: UL 651 with flexible bonding jumper.

F. UL ILNR - Fittings for Type FMC Duct Raceways:

1. Listing Criteria: UL CCN ILNR; including UL 514B.

G. UL DXAS - Fittings for Type LFMC Duct Raceways:

1. Listing Criteria: UL CCN DXAS; including UL 514B.

2.6 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
 2. Listing Criteria: UL CCN FOIZ; including UL Subject 2419.
- B. Source Quality Control:
1. Product Data: Prepare and submit catalog cuts, brochures, and performance data illustrating size, physical appearance, and other characteristics of product.
 2. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. UL FOIZ - Electrically Conductive Corrosion-Resistant Compound for Threaded Conduit.

PART 3 - EXECUTION

3.1 SELECTION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of duct raceways. Consult Architect for resolution of conflicting requirements.
- B. Outdoors:
1. Exposed and within the area of cooling towers and related to cooling towers: ERM-C-S-PVC.
 2. Exposed elsewhere: ERM-C-S.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFM-C-S.
- C. Indoors:
1. Exposed in clean room: ERM-C-S-PVC.
 2. Exposed in Chemical Feed Areas (Mechanical room near chemical system for cooling towers), around water softeners, and around RO System: ERM-C-S-PVC.
 3. Exposed in other areas not subject to physical damage: EMT-S.
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT-S.
 5. Damp or Wet Locations: ERM-C-S.
 6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFM-C.
- D. Duct Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERM-C: Provide threaded-type fittings unless otherwise indicated.
 2. All exterior and chemical feed area conduit terminations, exposed conduit terminations in NEMA 12 areas, and all control panels and junction boxes within mechanical and scrap destruction areas shall terminate with Myers threaded Hubs.
 3. Fittings shall be dust tight within scrap destruction room.

3.2 INSTALLATION OF CONDUITS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Type EMT-S: Article 358 of NFPA 70 and NECA NEIS 101.
 - 2. Type ERM-C-S: Article 344 of NFPA 70 and NECA NEIS 101.
 - 3. Type FMC-S: Article 348 of NFPA 70 and NECA NEIS 101.
 - 4. Type LFM-C-S: Article 350 of NFPA 70 and NECA NEIS 101.
 - 5. Expansion Fittings: NEMA FB 2.40.
 - 6. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. General Requirements for Installation of Duct Raceways:
 - a. Complete duct raceway installation before starting conductor installation.
 - b. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft above finished floor.
 - c. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
 - d. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 - e. Support conduit within 12 inch of enclosures to which attached.
 - f. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.
 - g. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following points:
 - 1) Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2) Conduit extending from interior to exterior of building.
 - 3) Conduit extending into pressurized duct raceway and equipment.
 - 4) Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - 5) Where otherwise required by NFPA 70.
 - h. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
 - i. Do not install conduits within 2 inch of the bottom side of a metal deck roof.
 - j. Keep duct raceways at least 6 inch away from parallel runs of flues and steam or hot-water pipes. Install horizontal duct raceway runs above water and steam piping.

- k. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 - l. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
 - m. Install duct raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 1) Termination fittings with shoulders do not require two locknuts.
 - n. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts..
2. Types ERM C:
- a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
3. Type ERM C-S-PVC:
- a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM C-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM C-S-PVC duct raceway.
 - c. Coat field-cut threads on PVC-coated duct raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
4. Types FMC and LFM C:
- a. Provide a maximum of 72 inch of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
5. Stub-ups to Above Recessed Ceilings:
- a. Provide EMT or ERM C for duct raceways.
 - b. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
6. Duct Raceway Terminations at Locations Subject to Moisture or Vibration:

- a. Provide insulating bushings to protect conductors, including conductors smaller than 4 AWG..
- 7. Duct Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.
 - a. ERM-C-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - b. EMT: Provide compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
 - c. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.
- 8. Expansion-Joint Fittings:
 - a. Install in runs of aboveground ERM-C and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 ft.
 - b. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - 1) Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - 2) Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - 3) Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - c. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - d. Install expansion fittings at locations where conduits cross building or structure expansion joints.
 - e. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's published instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- 9. Duct Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal duct raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.
- 10. Identification: Provide labels for conduit assemblies, duct raceways, and associated electrical equipment.
 - a. Provide warning signs.

D. Interfaces with Other Work:

- 1. Coordinate with Section 078413 "Penetration Firestopping" for installation of firestopping at penetrations of fire-rated floor and wall assemblies.

2. Coordinate with Section 260529 "Hangers and Supports for Electrical Systems" for installation of conduit hangers and supports.

3.3 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33.13

SECTION 26 05 33.16 - BOXES AND COVERS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.
3. Cover plates for device boxes.
4. Hoods for outlet boxes.

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

1. See Section 260553 "Identification for Electrical Systems" for electrical equipment labels.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Metallic outlet boxes, device boxes, rings, and covers.
2. Junction boxes and pull boxes.

PART 2 - PRODUCTS

2.1 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL CCN QCIT; including UL 514A.

B. UL QCIT - Metallic Outlet Boxes and Covers:

1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
2. Options:
 - a. Material: Sheet steel or Cast metal.
 - b. Sheet Metal Depth: Minimum 2.5 inch.
 - c. Cast-Metal Depth: Minimum 2.4 inch.

- d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire.
- C. UL QCIT - Metallic Conduit Bodies:
 - 1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
- D. UL QCIT - Metallic Device Boxes:
 - 1. Description: Box with provisions for mounting wiring device directly to box.
 - 2. Options:
 - a. Material: Sheet steel or Cast metal.
 - b. Sheet Metal Depth: minimum 2.5 inch.
 - c. Cast-Metal Depth: minimum 2.4 inch.
- E. UL QCIT - Metallic Extension Rings:
 - 1. Description: Ring intended to extend sides of outlet box or device box to increase box depth, volume, or both.

2.2 JUNCTION BOXES AND PULL BOXES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. Listing Criteria: UL CCN BGUZ; including UL 50 and UL 50E.
- B. UL BGUZ - Indoor Sheet Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Options:
 - a. Degree of Protection: Type 1 or Type 12.
- C. UL BGUZ - Indoor Cast-Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Options:
 - a. Degree of Protection: Type 1 or Type 12.
- D. UL BGUZ - Outdoor Sheet Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.

2. Options:
 - a. Degree of Protection: Type 4 or Type 4X Stainless Steel.

E. UL BGUZ - Outdoor Cast-Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Options:
 - a. Degree of Protection: Type 4 or Type 4X Stainless Steel.

2.3 COVER PLATES FOR DEVICES BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria: UL CCN QCIT or UL CCN QCMZ; including UL 514D.
3. Wallplate-Securing Screws: Metal with head color to match wallplate finish.

B. UL QCIT or QCMZ - Metallic Cover Plates for Device Boxes:

1. Options:
 - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - b. Wallplate Material: 0.032 inch thick, Type 302/304 non-magnetic stainless steel with brushed finish.

2.4 HOODS FOR OUTLET BOXES

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. Listing Criteria:
 - a. UL CCN QCIT or UL CCN QCMZ; including UL 514D.
 - b. Receptacle, Hood, Cover Plate, Gaskets, and Seals: UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
3. Mounts to box using fasteners different from wiring device.

B. UL QCIT or QCMZ - Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Additional Characteristics: Marked "Extra-Duty" in accordance with UL 514D.
2. Options:
 - a. Provides gray, weatherproof, "while-in-use" cover.

- b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

PART 3 - EXECUTION

3.1 SELECTION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Outdoors: Type 4X Stainless Steel (type 304).
 - 2. Indoors:
 - a. Type 1 where concealed within walls or ceilings
 - b. Type 12 where exposed.
 - c. Type 4X Stainless Steel around water softeners and RO System.
 - d. Type 12, 4, or 4X Stainless Steel in mechanical rooms.
- C. Exposed Boxes Installed Less Than 2.5 m (8 ft) Above Floor:
 - 1. Provide cast-metal boxes. Boxes with knockouts or unprotected openings are prohibited.
 - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.2 INSTALLATION OF BOXES AND COVERS FOR ELECTRICAL SYSTEMS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:
 - 1. Outlet, Device, Pull, and Junction Boxes: Article 314 of NFPA 70.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
 - 2. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
 - 3. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.

4. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
5. Locate boxes so that cover or plate will not span different building finishes.
6. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
7. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
8. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
9. Set metal floor boxes level and flush with finished floor surface.
10. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
11. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
12. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
13. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - a. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - b. Provide gaskets for wallplates and covers.
14. Identification: Provide labels for boxes and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Provide warning signs.
 - c. Label each box with engraved metal or laminated-plastic nameplate.

3.3 CLEANING

- A. Remove construction dust and debris from boxes before installing wallplates, covers, and hoods.

3.4 PROTECTION

- A. After installation, protect boxes from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 05 33.16

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round sleeves.
2. Rectangular sleeves.
3. Grout.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Steel Wall Sleeves:

1. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

B. Cast-Iron Wall Sleeves:

1. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.

C. Round, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics: Galvanized-steel sheet; thickness not less than 0.0239 inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 RECTANGULAR SLEEVES

A. Rectangular, Galvanized-Steel, Sheet Metal Sleeves:

1. General Characteristics:
 - a. Material: Galvanized sheet steel.
 - b. Minimum Metal Thickness:

- 1) For sleeve cross-section rectangle perimeter less than 50 inch and with no side larger than 16 inch, thickness must be 0.052 inch.
- 2) For sleeve cross-section rectangle perimeter not less than 50 inch or with one or more sides larger than 16 inch, thickness must be 0.138 inch.

2.3 GROUT

- A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 2. Design Mix: 5000 psi, 28-day compressive strength.
 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

3.2 INSTALLATION OF RECTANGULAR SLEEVES AND SLEEVE SEALS

- A. Install sleeves in existing walls without compromising structural integrity of walls. Do not cut structural elements without reinforcing the wall to maintain the designed weight bearing and wall stiffness.
- B. Install conduits and cable with no crossings within the sleeve.
- C. Fill opening around conduits and cables with expanding foam without leaving voids.
- D. Provide metal sheet covering at both wall surfaces and finish to match surrounding surfaces. Metal sheet must be same material as sleeve.

END OF SECTION 26 05 44

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:

1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft above finished floor.

C. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

- D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 1000 V or Less:
 - 1. Black letters on orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.
 - 1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Color for Neutral: White or gray.
 - 5. Color for Equipment Grounds: Green.
- C. Warning Label Colors:
 - 1. Identify system voltage with black letters on orange background.
 - 2. .
- D. Warning labels and signs must 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 3 FEET MINIMUM."

E. Equipment Identification Labels:

1. Black letters on white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil thick, polyester flexible label with acrylic pressure-sensitive adhesive.
 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend.
 2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inch for raceway and conductors.
 - b. 3-1/2 by 5 inch for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil thick by 1 to 2 inch wide; compounded for outdoor use.
- C. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.
- D. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory screened permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
 - 1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
 - 2. Marker for Tags:
 - a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4 inch grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inch.
- B. Metal-Backed Butyrate Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 - 2. 1/4 inch grommets in corners for mounting.
 - 3. Nominal Size: 10 by 14 inch.
- C. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:

- a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
- b. For signs larger than 20 sq. inch, 1/8 inch thick.
- c. Engraved legend with black letters on white face.
- d. Punched or drilled for mechanical fasteners with 1/4 inch grommets in corners for mounting.
- e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F in accordance with ASTM D638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- K. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- L. Snap-Around Labels: Secure tight to surface at location with high visibility and accessibility.

- M. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- N. Self-Adhesive Labels:
 - 1. Install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high label; where two lines of text are required, use labels 2 inch high.
- O. Snap-Around Color-Coding Bands: Secure tight to surface at location with high visibility and accessibility.
- P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at location with high visibility and accessibility.
- Q. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- R. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for minimum distance of 6 inch where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- S. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- T. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- U. Metal Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using general-purpose cable ties.
- V. Nonmetallic Preprinted Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using general-purpose cable ties.
- W. Write-on Tags:
 - 1. Place in location with high visibility and accessibility.
 - 2. Secure using general-purpose cable ties.
- X. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 - 2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on minimum 1-1/2 inch high sign; where two lines of text are required, use signs minimum 2 inch high.

Y. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

Z. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
2. Unless otherwise indicated, provide single line of text with 1/2 inch high letters on 1-1/2 inch high sign; where two lines of text are required, use labels 2 inch high.

AA. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 1000 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
1. Locate identification 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.
- D. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.
1. Locate identification 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.
- E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with conductor or cable designation, origin, and destination.
- F. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes with conductor designation.
- G. Conductors to Be Extended in Future: Attach write-on tags to conductors and list source.
- H. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- I. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- J. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.
 1. Apply to exterior of door, cover, or other access.
 2. For 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.
 - c. .
- L. Arc Flash Warning Labeling: Self-adhesive labels.
- M. Operating Instruction Signs: Self-adhesive labels.
- N. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on red background with minimum 3/8 inch high letters for emergency instructions at equipment used for power transfer.
- O. Equipment Identification Labels:
 1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchgear.
 - e. Switchboards.
 - f. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - g. Emergency system boxes and enclosures.
 - h. Enclosed switches.
 - i. Enclosed circuit breakers.
 - j. Enclosed controllers.
 - k. Variable-speed controllers.
 - l. Push-button stations.
 - m. Power-transfer equipment.

- n. Contactors.
- o. Remote-controlled switches, dimmer modules, and control devices.
- p. Battery-inverter units.
- q. Battery racks.
- r. Monitoring and control equipment.

END OF SECTION 26 05 53

SECTION 26 05 73.13 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, fault-current study to determine minimum interrupting capacity of circuit protective devices.

B. Related Requirements:

1. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.
2. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Short-Circuit Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

- a. Short-circuit study input data, including completed computer program input data sheets.
- b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- c. Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.4 QUALITY ASSURANCE

- A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Submittals for short circuit study must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ETAP - Digital Twin Platform.
 - 2. SKM Systems Analysis, Inc.
- B. Comply with IEEE 399 and IEEE 551.
- C. Analytical features of power systems analysis software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output.
- E. Computer program must be designed to perform short-circuit studies or have function, component, or add-on module designed to perform short-circuit studies.
- F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6. Derating factors and environmental conditions.
 - 7. Any revisions to electrical equipment required by study.
- D. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- E. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3. For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
 - 5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- F. Short-Circuit Study Input Data:
 - 1. One-line diagram of system being studied.
 - 2. Power sources available.
 - 3. Manufacturer, model, and interrupting rating of protective devices.
 - 4. Conductors.
 - 5. Transformer data.
- G. Short-Circuit Study Output Reports:
 - 1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.

- d. Equivalent impedance.
- 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
- 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of study.
 - 1. Verify completeness of data supplied on one-line diagram. Call discrepancies to Architect's attention.
 - 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 - 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers in accordance with NFPA 70E.
- B. Gather and tabulate required input data to support short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 - 1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are

- consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 9. Motor horsepower and NEMA MG 1 code letter designation.
 10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin short-circuit current analysis at service, extending down to system overcurrent protective devices as follows:
 1. To normal system low-voltage load buses where fault current is 5 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement to address asymmetrical requirements of interrupting equipment.
- H. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.
 1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.
- I. Include in report identification of protective device applied outside its capacity.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

END OF SECTION 26 05 73.13

SECTION 26 05 73.16 - COORDINATION STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.2 RELATED SECTIONS

1. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
2. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash studies.

1.3 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items must remain functional throughout construction period.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when abnormal current flow exists and then removes the affected portion of the circuit from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- F. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Coordination Study Report:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form.

- a. Coordination-study input data, including completed computer program input data sheets.
- b. Study and equipment evaluation reports.
- c. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- d. Revised one-line diagram, reflecting field investigation results and results of coordination study.

1.5 QUALITY ASSURANCE

- A. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Submittals for coordination study must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ETAP - Digital Twin Platform.
 2. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.

- c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.
- E. Computer program must be designed to perform coordination studies or have function, component, or add-on module designed to perform coordination studies.
- F. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 COORDINATION STUDY REPORT CONTENTS

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram of modeled power system, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, and panelboard designations.
 - 6. Revisions to electrical equipment required by study.
 - 7. Study Input Data: As described in "Power System Data" Article.
 - a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- D. Protective Device Coordination Study:
 - 1. Report recommended settings of protective devices, ready to be applied in field. Use manufacturer's data sheets for recording recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, and ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.

- c. Fuses: Show current rating, voltage, and class.
- E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for switching schemes and for emergency periods where power source is local generation. Show the following information:
 - 1. Device tag and title, one-line diagram with legend identifying portion of system covered.
 - 2. Terminate device characteristic curves at point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
 - 3. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
 - 4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Medium-voltage equipment overcurrent relays.
 - c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - f. Cables and conductors damage curves.
 - g. Ground-fault protective devices.
 - h. Motor-starting characteristics and motor damage points.
 - i. Generator short-circuit decrement curve and generator damage point.
 - j. Largest feeder circuit breaker in each motor-control center and panelboard.
 - 5. Maintain selectivity for tripping currents caused by overloads.
 - 6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
 - 7. Provide adequate time margins between device characteristics such that selective operation is achieved.
 - 8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of overcurrent protective device study.
1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Architect's attention.
 2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
 3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers must be in accordance with NFPA 70E.
- B. Gather and tabulate required input data to support coordination study. List below is guide. Comply with recommendations in IEEE 551 for amount of detail required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus (three phase and line to ground).
 5. Full-load current of loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 12. Maximum demands from service meters.
 13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
 14. Motor horsepower and NEMA MG 1 code letter designation.
 15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
 17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
- k. Identify series-rated interrupting devices for condition where available fault current is greater than interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.
- C. Base study on device characteristics supplied by device manufacturer.
- D. Extent of electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at service, extending down to system overcurrent protective devices as follows:
 - 1. To normal system low-voltage load buses where fault current is 5 kA or less.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device must not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings must protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands maximum short-circuit current for time equivalent to tripping time of primary relay protection or total clearing time of fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's instructions and to IEEE 242.

K. Include ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for three-phase bolted fault and single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide bolted line-to-ground fault-current study for areas as defined for three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Application of series-rated devices must be recertified, complying with requirements in NFPA 70.
4. Include in report identification of protective device applied outside its capacity.

3.4 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by coordination study. Field adjustments must be completed by engineering service division of equipment manufacturer under "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting must be by qualified low-voltage electrical testing and inspecting agency.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for adjustable overcurrent protective devices.

END OF SECTION 26 05 73.16

SECTION 26 05 73.19 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer-based, arc-flash study to determine arc-flash hazard distance and incident energy to which personnel could be exposed during work on or near electrical equipment.

B. Related Requirements:

1. Section 260573.13 "Short-Circuit Studies" for fault-current studies.
2. Section 260573.16 "Coordination Studies" for overcurrent protective device coordination studies.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. p.u.: Per unit. The reference unit, established as a calculating convenience, for expressing all power system electrical parameters on a common reference base.
- E. SCCR: Short-circuit current rating.
- F. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.
- G. Single-Line Diagram: See "One-Line Diagram."

1.3 ACTION SUBMITTALS

A. Product Data:

1. For power system analysis software to be used for studies.

B. Study Submittals:

1. Submit the following after approval of system protective devices submittals. Submittals must be in digital form:
 - a. Arc-flash study input data, including completed computer program input data sheets.
 - b. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
 - c. Revised one-line diagram, reflecting field investigation results and results of arc-flash study.

1.4 QUALITY ASSURANCE

- A. Study must be performed using commercially developed and distributed software designed specifically for power system analysis.
- B. Software algorithms must comply with requirements of standards and guides specified in this Section.
- C. Manual calculations are unacceptable.
- D. Submittals for Arc-Flash Hazard study must be signed and sealed by qualified electrical professional engineer responsible for their preparation.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ETAP - Digital Twin Platform.
 2. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program must have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer program must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.
- E. Computer program must be developed under supervision of licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

2.2 ARC-FLASH STUDY REPORT CONTENT

- A. Executive summary of study findings.
- B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Conductor types, sizes, and lengths.
 - 3. Transformer kVA and voltage ratings, including derating factors and environmental conditions.
 - 4. Motor and generator designations and kVA ratings.
 - 5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- D. Study Input Data: As described in "Power System Data" Article.
- E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
- F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."
- G. Arc-Flash Study Output Reports:
 - 1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- H. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Restricted approach boundary.
 - 6. Limited approach boundary.
 - 7. Working distance.
 - 8. Incident energy.
 - 9. Hazard risk category.
 - 10. Recommendations for arc-flash energy reduction.

- I. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce 3.5 by 5 inch self-adhesive equipment label for each work location included in analysis.
- B. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard analysis:
 1. Location designation.
 2. Nominal voltage.
 3. Protection boundaries.
 - a. Arc-flash boundary.
 - b. Restricted approach boundary.
 - c. Limited approach boundary.
 4. Arc flash PPE category.
 5. Required minimum arc rating of PPE in Cal/cm squared.
 6. Available incident energy.
 7. Working distance.
 8. Engineering report number, revision number, and issue date.
- C. Labels must be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Preparatory Studies: Perform Short-Circuit and Protective Device Coordination studies prior to starting Arc-Flash Hazard Analysis.
 1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
 2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. Maximum calculation must assume maximum contribution from utility and must assume motors to be operating under full-load conditions.
 - 2. Calculate arc-flash energy at 85 percent of maximum short-circuit current in accordance with IEEE 1584 recommendations.
- D. Calculate arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, including equipment fed from transformers smaller than 75 kVA.
- F. Calculate limited, restricted, and prohibited approach boundaries for each location.
- G. Incident energy calculations must consider accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations must take into account changing current contributions, as sources are interrupted or decremented with time. Fault contribution from motors and generators must be decremented as follows:
 - 1. Fault contribution from induction motors must not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators must be decayed to match actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 p.u. to 3 p.u. after 10 cycles).
- H. Arc-flash energy must generally be reported for maximum of line or load side of circuit breaker. However, arc-flash computation must be performed and reported for both line and load side of circuit breaker as follows:
 - 1. When circuit breaker is in separate enclosure.
 - 2. When line terminals of circuit breaker are separate from work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

- A. Obtain data necessary for conduct of arc-flash hazard analysis.
 - 1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
 - 2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
 - 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.
- B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to amount of detail that is required to be

acquired in field. Field data gathering must be under direct supervision and control of engineer in charge of performing study, and must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

- A. Apply one arc-flash label on front cover of each section of equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in study. Base arc-flash label data on highest values calculated at each location.
- B. Each piece of equipment listed below must have arc-flash label applied to it:
 1. Low-voltage switchgear.
 2. Switchboards.
 3. Panelboards.
 4. Low voltage transformers.
 5. Safety switches.
 6. Control panels.
- C. Note on record Drawings location of equipment where personnel could be exposed to arc-flash hazard during their work.
 1. Indicate arc-flash energy.

2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

- A. Install arc-flash warning labels under direct supervision and control of qualified electrical professional engineer.

END OF SECTION 26 05 73.19

SECTION 26 09 23 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Line-voltage wall-box occupancy sensors.
2. Digital ceiling mounted indoor occupancy sensors.
3. Digital relay panels.
4. Digital lighting system wall switches.
5. Digital Lighting control system conductors and cables.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for control modules, power distribution components, relays, manual switches and plates, and conductors and cables.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Sound data including results of operational tests of central dimming controls.
4. Operational documentation for software and firmware.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.
2. Include diagrams for power, signal, and control wiring.
3. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
4. Detail enclosure types and details for types other than NEMA 250, Type 1.
5. Detail wiring partition configuration, current, and voltage ratings.
6. Short-circuit current rating of relays.
7. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

C. Example Contractor Startup/Commissioning Worksheet.

D. Specification Conformance: Clearly indicate one of the following conditions:

1. The equipment and systems submitted conform exactly with project specifications and drawings.
2. The equipment and systems submitted meet the intent of the specification via an alternate means.

3. Provide a detailed statement indicating paragraph by paragraph and line by line wherein the equipment submitted deviates from the specifications.
4. Note all variations from the specified system on the Shop Drawings in 1/4" high bold notations.
5. Provide a narrative confirming specified function and detailing alternate means for achieving specified function.

E. Manufacturer's other than basis of design.

1. Alternate manufacturers are permitted as voluntary alternates. Contractor is responsible for providing a full system with capability and controllability meeting or exceeding of the Basis of Design product.
2. Submit along with bill of material a one line diagram of the system configuration proposed indicating the type, size and number of conductors between each component if it differs from that illustrated in the riser diagram in these specifications.
3. If the wiring requirements differ from the basis of design product, contractor shall provide alternate wiring diagrams to correlate to each lighting control wiring diagram included in the contract drawings. These diagrams are essential to the engineer and owner understanding exactly how the proposed substitution is configured and wired, and will be used in determining if substitution is acceptable.
4. A live demonstration of the proposed substitution system shall be provided to evaluate the product as a possible equal.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.
- B. Completed Contractor Startup/Commissioning Worksheet signed off by lighting control system manufacturer representative.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare lighting relay panels for installation according to NECA 407.

1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of lighting control devices that fail in materials or workmanship within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Damage from transient voltage surges.
 - b. Faulty operation of lighting control software.
 - c. Faulty operation of lighting control devices.
 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LINE-VOLTAGE WALL-BOX MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sensor Switch Inc, an Acuity Brands Company (800-727-7483, www.sensorswitch.com) or comparable product by one of the following:
1. Wattstopper.
 2. Leviton.
 3. Lutron.
 4. Hubbell.
 5. Cooper.
 6. Eaton.
 7. Pass & Seymour.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.
- C. Wall-Switch Sensor Tag OS:
1. Basis of Design Product: Sensor Switch model WSX PDT.
 2. Standard Range: 180-degree field of view; with a minimum coverage area of 20 ft radius from sensor.
 3. Sensing Technology: Dual technology - PIR and ultrasonic or microphonics.
 4. Switch Type: Single pole, field selectable automatic "on," or manual "on", automatic "off".
 5. Voltage: Match the circuit voltage.
 6. Field-adjustable, "off" time-delay selector from 30 seconds to 30 minutes.
- D. Wall-Switch Tag 2OS:
1. Basis of Design Product: Sensor Switch model WSX PDT 2P.
 2. Same as Tag OS, except with two relays, and two buttons to control two separate loads.
- E. Wall-Switch Sensor Tag \$DOS:
1. Basis of Design Product: Sensor Switch model WSX PDT D.
 2. Same as Tag OS except with Dimming Capability: 0-10V control.

2.2 DIGITAL LIGHTING CONTROL SYSTEM SUMMARY

- A. Basis-of-Design Product: Subject to compliance with requirements, provide nLight® Network Control System from Acuity Brands Lighting, Inc. or comparable product by one of the following:

1. Wattstopper.
 2. Leviton.
 3. Lutron.
- B. Sequence of Operations: Input signal from field-mounted manual switches, or digital signal sources, shall open or close one or more lighting control relays in the lighting control system. Any combination of inputs shall be programmable to any number of control relays.
- C. Lighting control system shall be a wired system. Wireless devices and devices requiring batteries are prohibited.
- D. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photocell sensors, relays, dimming outputs, manual switch stations, and manual dimming stations.
- E. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation with no headend system.
- F. System shall be capable of operating a lighting control zone according to several sequences of operation.
- G. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

2.3 DIGITAL LIGHTING SYSTEM INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 3. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 4. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 5. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
 6. Dry Contact Output: Every sensor shall be provided with an auxiliary low voltage relay for dry contact output to track occupancy for connection to HVAC/BAS control system.
- B. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic or microphonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Basis of Design Product: nLight model nCM PDT 9 AR
2. Sensitivity Adjustment: Separate for each sensing technology.
3. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
4. Detection Coverage: Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.4 DIGITAL LIGHTING SYSTEM WALL SWITCHES

- A. Basis of Design Product: nLight model series nPODM, specific model number as indicated on drawings for various applications.
- B. Devices shall recess into single-gang switch box and fit a standard decora opening.
- C. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
- D. Provide custom button labeling/engraving/etching consistent with requirements noted on drawings to identify what each button controls.
- E. Coordinate finish and wall plate with Section 262726 "Wiring Devices."

2.5 DIGITAL LIGHTING SYSTEM CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Class 2 Control Cable: Category 5e Cable with RJ45 connectors.
 1. 100-ohm, four-pair UTP.
 2. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
 3. Comply with TIA-568-C.1 for performance specifications.
 4. Comply with TIA-568-C.2, Category 5e.
 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following type: Communications, Plenum Rated: Type CMP complying with UL 1685.
 6. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-C.1.
 7. Cable shall have protective jacket of a unique consistent color differing from telecommunications and data wiring within building. Provide green cable jacket to readily identify cabling as other than normal telephone and data wiring.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install occupancy sensors and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- D. Install indoor photosensors and outdoor photocells in accordance with manufacturer's written instructions and recommendations.

3.3 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in on relay/power packs.
- B. Label all digital lighting control system components with a unique designation.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 1. Operational Test: After installing switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service, test, inspect components, assemblies, and equipment installations, including connections.
 1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Confirm correct communications wiring, initiate communications between panels, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
 3. Program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.
 4. Perform operational tests within presence of the owner for operation of all switches, and other human interface devices.
 5. Confirm time clock schedules, overrides, occupancy sensors, photosensors, photocells, and all lighting control devices and light control system operate as specified within the contract drawings and specifications.
 6. Coordinate with owner for specific building operations requirements with regard to the lighting control system including but not limited to: time clock schedule, night lighting requirements, labeling designations, etc.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors and lighting control system functionality to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 2. For indoor photosensors and outdoor photocells, verify operation of sensors. Set on/off set-point and a deadband delay to suit Owner's operations.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

3.9 DOCUMENTATION

- A. Provide Operation and Maintenance manuals in accordance with Division 01 Specification Sections.
- B. Each relay pack shall have an identification label indicating the originating branch circuit number and panelboard name as indicated on the drawings. Each line side branch circuit conductor shall have an identification tag indicating the branch circuit number.
- C. If lighting control system differs from basis of design and contract drawings provide a point-to-point wiring diagram for the entire lighting control system. Diagram must indicate actual mounting location of each system device. This accurate "as built" shall indicate the loads controlled by each relay/power pack and the identification number for that relay, placement of switch, sensors, and other devices.

END OF SECTION 260923

SECTION 26 22 13 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.
- C. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger:
 - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
 - 2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.
- D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume must allow efficient transformer operation at 10 percent above nominal tap voltage.
 - 3. Grounded to enclosure.

- C. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Copper.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal Connections: Welded.
- D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
 - 1. Core and coil must be encapsulated within resin compound using vacuum-pressure impregnation process to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
 - 3. Wiring Compartment: Sized for conduit entry and wiring installation.
 - 4. Environmental Protection:
 - a. Indoor: UL 50E, Type 2.
 - 5. Finish Color: Gray weather-resistant enamel.
- F. Taps for Transformers 3 kVA and Smaller: None.
- G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.
- K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- L. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding shield.
- M. Wall Brackets: Manufacturer's standard brackets.
- N. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dB(A-weighted).
 - 2. 9.01 to 30.00 kVA: 45 dB(A-weighted).
 - 3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9.

4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9.

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Administrator: Engage qualified electrical testing agency to evaluate transformer.

B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:
 - a. Line-side to ground.
 - b. Load-side to ground.
 - c. Line-side to load-side.

9. Temperature tests.

C. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- ### A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance must be 5 Ω at location of transformer.
- E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

- 1. Contractor shall provide all necessary measuring equipment and tools necessary to perform the test necessary for acceptance testing

B. Tests and Inspections:

- 1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

- a. Visual and Mechanical Inspection.

- 1) Inspect physical and mechanical condition.
- 2) Inspect anchorage, alignment, and grounding.
- 3) Verify that resilient mounts are free and that shipping brackets have been removed.
- 4) Verify that unit is clean.
- 5) Perform specific inspections and mechanical tests recommended by manufacturer.
- 6) Verify that as-left tap connections are as specified.
- 7) Verify presence of surge arresters and that their ratings are as specified.

- b. Electrical Tests:

- 1) Measure resistance at windings, taps, and bolted connections.
- 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
- 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
- 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

- C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

D. Nonconforming Work:

- 1. Transformer will be considered defective if it does not pass tests and inspections.

2. Remove and replace units that do not pass tests or inspections and retest as specified above.

- E. Assemble and submit test and inspection reports.

3.5 ADJUSTING

- A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

- A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.
 1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
 3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262213

SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Switchboards.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.

1.2 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Switchboards.
2. Overcurrent protective devices.
3. Surge protection devices.
4. Ground-fault protection devices.
5. Accessories.
6. Other components.
7. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than UL 50E, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
6. Include schematic and wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Handling, storing, and providing temporary heat.
 - 2. Mounting accessories and anchoring devices.
 - 3. Testing and adjusting overcurrent protective devices.
- B. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents.
 - 1. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation in accordance with NEMA PB 2.1.

1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA model QED-2 to match building standard.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.
- H. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Fixed, individually mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- I. Indoor Enclosures: Steel, UL 50E, Type 1.
- J. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.
- K. Barriers: Between adjacent switchboard sections.
- L. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- M. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- N. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- O. Buses and Connections: Three phase, four wire unless otherwise indicated.
 - 1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
 - 2. Phase- and Neutral-Bus Material:

- a. Hard-drawn copper of 98 percent conductivity, silver-plated.
- 3. Copper feeder circuit-breaker line connections.
- 4. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
- 5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
- 6. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- P. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- Q. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

2.2 SURGE PROTECTION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA.
- B. SPDs: Listed and labeled in accordance with UL 1449, Type 2.
- C. Features and Accessories:
 - 1. Integral disconnect switch.
 - 2. Internal thermal protection that disconnects SPD before damaging internal suppressor components.
 - 3. Indicator light display for protection status.
 - 4. Form-C contacts rated at 5 A and 250 V(ac), one normally open and one normally closed, for remote monitoring of protection status.
 - 5. Surge counter.
- D. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase may not be less than 200 kA. Peak surge current rating must be arithmetic sum of ratings of individual MOVs in each mode.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits may not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V.
 - 3. Line to Line: 2000 V for 480Y/277 V.
- F. SCCR: Equal or exceed 200 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
 - 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - d. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards in accordance with NEMA PB 2.1.
 - 1. Lift or move switchboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's published instructions.
 - 2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
 - 3. Protect from moisture, dust, dirt, and debris during storage and installation.
 - 4. Install temporary heating during storage in accordance with manufacturer's published instructions.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect performance of equipment.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 2.1.
 - 2. Consult Engineer for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting: Install switchboards on concrete base, 4 inch nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."
 - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch above concrete base after switchboard is anchored in place.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch centers around full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to switchboards.
 - f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
 - 2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
 - 3. Operating Instructions: Frame and mount printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
 - 4. Install filler plates in unused spaces of panel-mounted sections.
 - 5. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - a. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- C. Support and secure conductors within switchboard in accordance with NFPA 70.
- D. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner's Representative.
- B. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 3. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.

- b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- 5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
 - 1. Switchboard will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.8 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature in accordance with manufacturer's published instructions, until switchboard is ready to be energized and placed into service.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.

1.2 DEFINITIONS

- A. GFEP: Ground-fault equipment protection.
- B. MCCB: Molded-case circuit breaker.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Power panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Disconnecting and overcurrent protective devices.
4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards.

- B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Recommended procedures for installing panelboards.
 - 2. Recommended torque settings for bolted connections on panelboards.
 - 3. Recommended temperature range for energizing panelboards.
- C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Keys: Two spares for each type of panelboard cabinet lock.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation in accordance with NECA 407.

PART 2 - PRODUCTS

2.1 PANELBOARD COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1.
 - b. Outdoor Locations: UL 50E, Type 4X Stainless Steel.

- c. Other Wet or Damp Indoor Locations: UL 50E, Type 4X Stainless Steel.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.
- 2. Height: 7 ft (2.13 m) maximum.
- 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims must cover live parts and may have no exposed hardware.
- 4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
- 5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
- 6. Finishes:
 - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- F. Incoming Mains:
 - 1. Location: Top or Bottom.
 - 2. Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 - 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
 - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
 - 5. Do not mount neutral bus in gutter.
- H. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum.
 - 2. Terminations must allow use of 75 deg C rated conductors without derating.
 - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 - 4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
 - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
 - 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

- I. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- J. Panelboard Short-Circuit Current Rating:
 - 1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

2.2 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA, model I-Line to match building standard.
- B. Listing Criteria: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inch high, provide two latches, keyed alike.
- D. Mains: Circuit breaker or Lugs only as indicated on the drawings in the panelboard schedules.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal].

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA, model NF and NQ to match building standard.
- B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- E. Doors: Door-in-door construction with concealed hinges; secured with flush latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Square D; Schneider Electric USA, to match building standard.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c.
 - d. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 - 3. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 - 4. GFEP Circuit Breakers: Class B ground-fault protection (30 mA trip).
 - 5. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240 V, single-pole configuration.
 - 6. Subfeed Circuit Breakers: Vertically mounted.
 - 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. UL listed for reverse connection without restrictive line or load ratings.
 - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
 - f. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

- i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units.
- j. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Multipole units enclosed in single housing with single handle.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Install free standing distribution panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - b. Attach panelboard to vertical finished or structural surface behind panelboard.
 - c. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
3. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
4. Mount panelboard cabinet plumb and rigid without distortion of box.
5. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
6. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
7. Install filler plates in unused spaces.
8. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Device Nameplates: Label each branch circuit device in power panelboards with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- E. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.
- F. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- G. Circuit Directory:
 1. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

- a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
2. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Field tests and inspections must be witnessed by Owner's Representative.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

END OF SECTION 26 24 16

SECTION 26 25 00 - LOW-VOLTAGE ENCLOSED BUS ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Enclosed bus assemblies.

1.2 ACTION SUBMITTALS

A. Shop Drawings: For each type of product.

1. Show fabrication and installation details for enclosed bus assemblies. Include plans, elevations, and sections of components. Designate components and accessories, including clamps, brackets, hanger rods, connectors, straight lengths, and fittings.
2. Show fittings, materials, fabrication, and installation methods for listed firestop barriers.
3. Indicate required clearances, method of field assembly, and location and size of each field connection.
4. Detail connections to switchgear, switchboards, transformers, and panelboards.
5. Cable and conductor terminal sizes for bus and plug-in device terminations.
6. Wiring Diagrams: Power wiring.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle enclosed bus assemblies according to NEMA BU 1.1, "General Instructions for Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less."

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Source Limitations: Obtain enclosed bus assemblies from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Comply with UL 857.

2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified electrical professional engineer to design enclosed bus assemblies, and components.

2.3 ENCLOSED BUS ASSEMBLIES

- A. Feeder-Bus Assemblies: Low-impedance bus assemblies in totally enclosed, nonventilated housing; single-bolt joints; ratings as indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Eaton.
 - c. Siemens Industry, Inc., Energy Management Division.
 - d. Square D; Schneider Electric USA.
 - 2. Electrical Characteristics:
 - a. Voltage: 277/480 V.
 - b. Phase: Three; 4 wire.
 - c. Percent of Neutral Capacity: 100.
 - 3. Short-Circuit Interrupting Rating:
 - a. For Bus Amperage of 800: 85 symmetrical kAIC.
 - b. For Bus Amperage of 1200: 100 symmetrical kAIC.
 - c. For Bus Amperage of 1600: 125 symmetrical kAIC.
 - d. For Bus Amperage of 2500: 150 symmetrical kAIC.
 - e. For Bus Amperage of 5000: 200 symmetrical kAIC.
 - 4. Temperature Rise: 55 deg C above 40 deg C ambient maximum for continuous rated current.
 - 5. Bus Materials: Current-carrying copper conductors, fully insulated with Class 130C insulation except at joints; plated surface at joints.
 - 6. Voltage Drop:
 - a. Measure voltage drop at 30 deg C ambient with bus thermally stabilized at full rated load.
 - b. Three-phase, line-to-line voltage drop less than 3.1 V per 100 ft. (30.5 m) at 40 percent power factor.
 - 7. Ground: 50 percent capacity, internal bus bar of material matching bus material.
 - 8. Enclosure: Steel, with manufacturer's standard finish.
 - 9. Fittings and Accessories: Manufacturer's standard.

10. Firestop: Comply with UL 1479 firestop system, listed and labeled by an NRTL acceptable to authorities having jurisdiction for penetrations of fire-rated walls, ceilings, and floors.
11. Mounting: Arranged flat, edgewise, or vertically without derating. Rated for hanger spacing of up to 10 ft. (3 m) for horizontally mounted runs and up to 16 ft. (5 m) for vertically mounted runs.
12. Expansion Section: Manufacturer's standard expansion fitting for the provided busway with expansion capability to accommodate thermal expansion of bus and enclosure, and to accommodate movement across building expansion joints.

B. Joints:

1. Busway joints must use one high-strength steel bolt with Belleville washers.
2. Bolts must be torque indicating type and at ground potential.
3. Bolts must be two-headed design to indicate when proper torque has been applied and require only a standard long handle wrench to be properly activated.
4. Access must be required to only one side of the busway for tightening joint bolts.
5. Joint connection assemblies must be removable without disturbing adjacent busway lengths.
6. Joint connection assemblies that rely on the joint cover to provide ground continuity are unacceptable.

2.4 CABLE TAP BOX

- A. Provide cable tap boxes of voltage and current rating as indicated on the drawings. Cable tap box shall provide busway to cable termination of busway. Cable tap box shall include cable lugs suitable for termination of conductors as indicated on the drawings.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB.
 - b. Eaton.
 - c. Siemens Industry, Inc., Energy Management Division.
 - d. Square D; Schneider Electric USA.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Coordinate layout and installation of enclosed bus assemblies and suspension system with other construction that penetrates ceilings or floors or is supported by them, including luminaires, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Equipment Mounting:
1. Coordinate size and location of concrete curbs around openings for vertical bus. Concrete, reinforcement, and formwork requirements are specified with concrete.

- C. Support bus assemblies independent of supports for other elements such as equipment enclosures at connections to panelboards and switchboards, pipes, conduits, ceilings, and ducts.
 - 1. Design each fastener and support to carry 200 lb (90 kg) or 4 times the weight of bus assembly, whichever is greater.
 - 2. Support bus assembly to prevent twisting from eccentric loading.
 - 3. Support bus assembly with not less than 3/8 inch (10 mm) steel rods. Install side bracing to prevent swaying or movement of bus assembly. Modify supports after completion to eliminate strains and stresses on bus bars and housings.
 - 4. Fasten supports securely to building structure according to Section 260529 "Hangers and Supports for Electrical Systems."
 - 5. Bolts and nuts that are loosened for any reason after tightening to manufacturer's recommended torque setting must be discarded and replaced with new bolts and nuts.
- D. Install expansion fittings at locations where bus assemblies cross building expansion joints. Install at other locations so distance between expansion fittings does not exceed manufacturer's recommended distance between fittings.
- E. Construct rated firestop assemblies where bus assemblies penetrate fire-rated elements such as walls, floors, and ceilings. Seal around penetrations according to Section 078413 "Penetration Firestopping."
- F. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.
- G. Tighten bus-assembly joints with torque wrench or similar tool recommended by bus-assembly manufacturer. Tighten joints again after bus assemblies have been energized for 30 days.

3.2 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Terminate to switchboard enclosures with matching bus assemblies according to Section 262413 "Switchboards."

3.3 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Owner's Representative.
- B. Tests and Inspections:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.

- b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify correct connection according to single-line diagram.
 - e. Inspect bolted electrical connections for high resistance using one or more of the following methods:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - 3) Perform thermographic survey.
 - 3. Electrical Tests:
 - a. Perform insulation resistance measurements through bolted connections and bus joints with low-resistance ohmmeter.
 - b. Perform insulation resistance tests of each busway, phase to phase, and phase to ground.
 - c. Perform a dielectric withstand voltage test on each busway, phase to ground with phases not under test grounded for one minute.
 - d. Measure resistance of assembled busway sections on insulated busway and compare values with adjacent phases.
 - e. Perform phasing test on each busway tie section energized by separate sources.
 - f. Verify operation of busway space heaters.
 - C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 - 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.
 - E. Nonconforming Work:
 - 1. Enclosed bus assemblies will be considered defective if they do not pass tests and inspections.
 - F. Prepare test and inspection reports.
- 3.4 CLEANING
- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.5 PROTECTION

- A. Provide final protection to ensure that moisture does not enter bus assembly.

END OF SECTION 262500

SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General-use switches
2. General-grade single straight-blade receptacles.
3. General-grade duplex straight-blade receptacles.
4. Receptacles with ground-fault protective devices.
5. Locking receptacles.
6. Connectors, cords, and plugs.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.

1.2 ACTION SUBMITTALS

A. Product Data of all products

PART 2 - PRODUCTS

A. GENERAL-USE SWITCHES:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
4. Options:

- a. Device Color: Brown.
- b. Configuration:
 - 1) Extra-heavy-duty, 120-277 V, 20 A, single pole, double pole, three way, and four way.

2.2 GENERAL-GRADE SINGLE STRAIGHT-BLADE RECEPTACLES

A. Single Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
4. Options:
 - a. Device Color: Brown.
 - b. Configuration:
 - 1) Heavy-duty, NEMA 5-50R.
 - 2) Extra-heavy-duty, NEMA 5-20R.

2.3 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.

2. Regulatory Requirements:

- a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

3. General Characteristics:

- a. Reference Standards: UL CCN RTRT and UL 498.

4. Options:

- a. Device Color: Brown.
- b. Configuration:
 - 1) Extra-heavy-duty, NEMA 5-20R.

2.4 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

A. General-Grade, Duplex Straight-Blade Receptacle with GFCI Device:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
- 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 3. General Characteristics:
 - a. Reference Standards: UL CCN AWBZ, UL 498, UL 1699, and UL Subject 1699A.
- 4. Options:
 - a. Device Color: Brown.
 - b. Configuration: Heavy-duty, NEMA 5-20R.

B. General-Grade, Weather-Resistant, Duplex Straight-Blade Receptacle with GFCI Device:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.

- b. Hubbell Wiring Device-Kellems; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour; Legrand North America, LLC.
- 2. Regulatory Requirements:
 - a. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- 3. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
- 4. Options:
 - a. Device Color: Brown.
 - b. Configuration: Heavy-duty, NEMA 5-20R.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receptacles:
 - 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Consult Architect for resolution of conflicting requirements.
- C. Identification:
 - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
- B. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' instructions, comply with installation instructions in NECA NEIS 130.
 - 2. Mounting Heights: Unless otherwise indicated in Contract Documents, comply with mounting heights recommended in NECA NEIS 1.
 - 3. Receptacle Orientation: Unless otherwise indicated in Contract Documents, orient receptacle to match configuration diagram in NEMA WD 6.
 - 4. Consult Engineer for resolution of conflicting requirements.
- C. Identification:
 - 1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."
 - a. Mark cover or cover plate using hot, stamped, or engraved machine printing with black-filled lettering, and provide durable wire markers or tags inside device box or outlet box.

3.4 FIELD QUALITY CONTROL OF SWITCHES

- A. Field tests and inspections must be witnessed by General Contractor.
- B. Tests and Inspections:
 - 1. Perform tests and inspections in accordance with manufacturers' instructions.
- C. Nonconforming Work:
 - 1. Unit will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Assemble and submit test and inspection reports.

3.5 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- A. Field tests and inspections must be witnessed by Owner Representative.
- B. Tests and Inspections:
 - 1. Insert and remove test plug to verify that device is securely mounted.
 - 2. Verify polarity of hot and neutral pins.
 - 3. Measure line voltage.
 - 4. Measure percent voltage drop.
 - 5. Measure grounding circuit continuity; impedance must be not greater than 2 ohms.

6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.

C. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

D. Assemble and submit test and inspection reports.

3.6 PROTECTION

A. Devices:

1. Schedule and sequence installation to minimize risk of contamination of wires and cables, devices, device boxes, outlet boxes, covers, and cover plates by plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other materials.
2. After installation, protect wires and cables, devices, device boxes, outlet boxes, covers, and cover plates from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 27 26

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Enclosed controllers.
 - c. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Coordination charts and tables and related data.

1.3 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Bussmann; Eaton, Electrical Sector.

2. Littelfuse, Inc.
3. Mersen USA.

- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
1. Type RK-1: 250 or 600-V, zero- to 600-A rating, 200 kAIC, time delay.
 2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
1. Feeders: Class RK1, time delay.
 2. Motor Branch Circuits: Class RK1, time delay.

3. Control Transformer Circuits: Class CC, time delay, control transformer duty.
4. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 26 28 16 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.2 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB, Electrification Business.
 - 2. Eaton.
 - 3. Siemens Industry, Inc., Energy Management Division.
 - 4. Square D; Schneider Electric USA.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
 - 3. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Hookstick Handle: Allows use of hookstick to operate handle.
 - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

- A. Enclosed Switches: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

- B. Enclosure Finish: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1), gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (UL 50E Types 3R, 12), a brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel).
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 4X Stainless Steel.
- C. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: UL 50E, Type 12.

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches with tops at uniform height unless otherwise indicated.
 - 3. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 4. Install fuses in fusible devices.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by Owner's Representative.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, grounding, and clearances.
- c. Verify that unit is clean.
- d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Nonconforming Work:

- 1. Enclosed switches will be considered defective if they do not pass tests and inspections.
- 2. Remove and replace defective units and retest.

D. Collect, assemble, and submit test and inspection reports.

- 1. Test procedures used.
- 2. Include identification of each enclosed switch tested and describe test results.
- 3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 PROTECTION

- A. After installation, protect enclosed switches from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 26 28 16

SECTION 26 29 13.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manual motor controllers.
 - 2. Combination full-voltage magnetic motor controllers.
 - 3. Enclosures.
 - 4. Accessories.
 - 5. Identification.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. OCPD: Overcurrent protective device.
- F. SCCR: Short-circuit current rating.
- G. SCPD: Short-circuit protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of magnetic controller.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.

3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.
 - a. Listing document proving Type 2 coordination.
7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by an NRTL acceptable to authorities having jurisdiction.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.
1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Routine maintenance requirements for magnetic controllers and installed components.
 - b. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - c. Manufacturer's written instructions for setting field-adjustable overload relays.
 - d. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
 - e. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 FIELD CONDITIONS

- A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet for electromagnetic and manual devices.
 - 3. The effect of solar radiation is not significant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Motion Business.
 - b. Eaton.
 - c. Siemens Industry, Inc., Energy Management Division.
 - d. Square D; Schneider Electric USA.
 - 2. Standard: Comply with NEMA ICS 2, general purpose, Class A.
 - 3. Configuration: Nonreversing.
 - 4. Surface mounting.
 - 5. Red pilot light.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Eaton.
 - c. Siemens Industry, Inc., Energy Management Division.
2. Configuration: Nonreversing.
3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 20 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
4. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
5. Pilot Light: Red.

2.3 COMBINATION FULL-VOLTAGE MAGNETIC MOTOR CONTROLLER

- A. Description: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. ABB, Electrification Business.
 2. Eaton.
 3. Siemens Industry, Inc., Energy Management Division.
 4. Square D; Schneider Electric USA.
- C. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- D. Configuration: Nonreversing.
- E. Contactor Coils: Pressure-encapsulated type.
 1. Operating Voltage: Manufacturer's standard, unless indicated.
- F. Control Power:
 1. For on-board control power, obtain from integral CPT. The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
 - a. Spare CPT Capacity as Indicated on Drawings: 50 VA.
- G. Overload Relays:
 1. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

H. Fusible Disconnecting Means:

1. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.4 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.

2.5 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.
- B. Breather assemblies, to maintain interior pressure and release condensation in Type 4Type 4X] enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- C. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.6 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 260553 "Identification for Electrical Systems," for each compartment, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
- D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- E. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- F. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:

- 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
3. Electrical Tests:
 - a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
 - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
 - a. Comply with the recommendations of NFPA 70B, "Testing and Test Methods" Chapter, "Infrared Inspection" Article.
 - b. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
 - c. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each motor controller 11 months after date of Substantial Completion.
 - d. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:

- 1) Description of equipment to be tested.
 - 2) Discrepancies.
 - 3) Temperature difference between the area of concern and the reference area.
 - 4) Probable cause of temperature difference.
 - 5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
 - 6) Load conditions at time of inspection.
 - 7) Photographs and thermograms of the deficient area.
 - 8) Recommended action.
- e. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.
- f. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
- C. Motor controller will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain controllers.

END OF SECTION 262913.03

SECTION 26 33 00 - HEAT TRACING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes piping heat tracing for freeze prevention with self-regulating, parallel resistance electric heating cables.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
 - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Basis-of-Design: Raychem XL-Trace. (Raychem is a division of Pentair Thermal Building Solutions).
 2. Chromolox.
 3. Thermon.
- B. Comply with IEEE 515.1.
- C. Heating Element: Radiation cross-linked, semi-conductive core extruded over two parallel, stranded 16 AWG bus wires. The heating element shall be of the self-regulating type, varying its power output inversely with pipe temperature at every point along its entire length such that power output is reduced as temperature increases and so that it can be cut to length in field without affecting power output per unit length. Terminate with waterproof, factory-assembled non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin or fluoropolymer.
- E. Cable Cover: Tinned-copper braid.
- F. Maximum Operating Temperature (Power On): 150 degrees F.
- G. Maximum Intermittent Exposure Temperature (Power Off): 185 degrees F.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- I. Capacities and Characteristics:
 1. Maximum Heat Output: 8 W/ft.
 2. Piping Diameter: Refer to plumbing and food service drawings and specifications for information on piping diameter.
 - a. Volts: 120.
 - b. Phase: Single Phase.
 - c. Hertz: 60 Hz.

2.2 CONTROLS

- A. Ambient sensing thermostat with adjustable temperature range from 15 to 140 degrees F and properly sized contactor for power panel. Circuits shall be energized when ambient temperature drops to 40 degrees F.
- B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.
- C. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

- A. Cable Installation Accessories: Electrical heat tracing components, power connections, splices, tees and end seals shall be by the same manufacturer as the heat tracing cable and shall be approved by a certifying agency for installation in the designated areas.
- B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
 - 1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.
 - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install electric heating cable according to manufacturer's written recommendations using slack cable to allow easy removal of maintenance items such as pumps, valves, strainers and filters without damage to the cable.
- B. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- C. Electric Heating-Cable Installation for Freeze Protection for Piping:

1. Install electric heating cables after the completion of piping tests and piping rework to avert possible physical damage to the cables.
 2. Install cables before insulation is installed.
 3. Install electric heating cables according to IEEE 515.1.
 4. Install insulation over piping with electric cables according to Division 23 Section "Mechanical Insulation."
 5. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- D. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Protect installed heating cables, including non-heating leads, from damage.
- F. Do not use heat transfer cement of any type in electric heating cable installation.

3.3 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction.
 2. Test cables for electrical continuity and insulation integrity before energizing.
 - a. Meggered the heater cable to verify no damage has occurred. Conduct test using a 2500 VDC megger. Do not use a megger with an excess of 2500 VDC for polymer heater cables. Minimum acceptable readings should be 20 megohms per circuit, regardless of length
 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously. Document measurements to verify the installation is functioning properly.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.5 PROTECTION

- A. Protect installed heating cables, including non-heating leads, from damage during construction.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

- B. Remove and replace damaged heat-tracing cables.

END OF SECTION 263300

SECTION 26 33 23.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Uninterruptible (UPS-type) central battery equipment.
 - 2. Enclosures.
 - 3. Optional and accessory features.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).
- C. LED: Light-emitting diode.
- D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- E. OCPD: Overcurrent protective device.
- F. PC: Personal computer.
- G. PWM: Pulse-width modulated.
- H. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).
- I. THD(V): Total harmonic voltage demand.
- J. Uninterruptible: As used in the Section Text, an on-line, double-conversion (rectifier/inverter) unit, with no interruption of power to the load on interruption and restoration of the "normal" source.

- K. UPS: Uninterruptible power supply.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and rating of central battery equipment unit.
 - 1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.
- B. Shop Drawings: For each type and rating of central battery equipment unit.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
 - 3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
 - 4. Include elevation, details, and legends of control and indication displays.
 - 5. Include -circuit current (withstand) rating of unit.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- B. Qualification Data: For testing agency.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For central battery equipment to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Manufacturer's written instructions for testing central battery equipment.
 - b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 - c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in fully enclosed vehicles.
- B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.
 - 1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:
 - a. Central Battery Equipment (excluding Batteries): Two year(s).
 - b. Lithium-ion Batteries:
 - 1) Full Warranty: Two year(s).
 - 2) Pro Rata: Nine years.

PART 2 - PRODUCTS

2.1 UNINTERRUPTIBLE (UPS-TYPE) CENTRAL BATTERY EQUIPMENT

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Dual-Lite; brand of Hubbell Electrical Solutions; Hubbell Incorporated model TRF-480-4-65-480 or a comparable product by one of the following:
 - 1. Eaton.
 - 2. Schneider Electric.
 - 3. Myers Emergency Power Systems
- B. General Requirements for Central Battery Equipment:
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
 - 3. Comply with the IBC, NFPA 70, and NFPA 101.
 - 4. Comply with NEMA PE 1.
- C. Performance Requirements for UPS-Type Central Battery Equipment:

1. Type: On-line, double conversion.
2. Continuously provide uninterrupted ac power to connected emergency electrical lighting system.
3. Automatic Operation:
 - a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier and inverter, with battery connected in parallel with rectifier output.
 - b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
 - c. If normal power fails, battery continues to supply regulated ac power through the inverter to the load without switching or disturbance.
 - d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier then supplies power to the load through the inverter and simultaneously recharges battery.
 - e. If battery becomes discharged and normal supply is available, rectifier charges battery. When battery is fully charged, rectifier automatically shifts to float-charge mode.
 - f. If any element in the rectifier/inverter string fails and power is available at normal supply terminals of system, static transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
 - g. If a fault occurs in system supplied by the inverter output, and current flows in excess of the overload rating of the inverter, static transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
 - h. When fault has cleared, static transfer switch returns the load to inverter output.
 - i. If battery is disconnected, inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.
4. Manual Operation:
 - a. Turning inverter off causes static transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
 - b. Turning inverter on causes static transfer switch to transfer the load to inverter.
5. Maximum Acoustical Noise: 65 dB, "A" weighting, emanating from any UPS component under any condition of normal operation, measured 39 inches from nearest surface of component enclosure.

D. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 99 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.

7. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
 8. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.
 9. Humidity Rating: Less than 95 percent (noncondensing).
 10. Altitude Rating: Not exceeding 3300 feet.
 11. Off-Line Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
- E. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.
- F. Controls and Indication:
1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:
 - a. Normal power available.
 - b. Status of system.
 - c. Battery charging status.
 - d. On battery power.
 - e. System fault.
 - f. External fault.
 2. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
 - a. Keypad: In addition to required programming and control keys, include the following:
 - 1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
 - 2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
 - 3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.
 - b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:
 - 1) Real-time clock with current time and date.
 - 2) Tests and Events Logs: Record and store up to 50 tests and events:
 - a) Dates.
 - b) Times.
 - c) Durations.
 - d) Output voltage and currents.
 - 3) Alarm Logs: Record and store up to 50 alarms:
 - a) Dates.

- b) Times.
 - c) Alarm type.
 - 4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:
 - a) Input and output voltage (V ac) and output current (A ac).
 - b) Battery voltage (V dc) and current (A ac).
 - c) Fault or alarming status (code).
 - d) Power output (VA).
 - e) Inverter load (W).
 - f) Ambient temperature (deg F).
 - g) System run time (cumulative days).
 - h) Inverter run time (cumulative minutes).
 - 5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:
 - a) High/low battery charge voltage.
 - b) High/low input voltage.
 - c) Battery nearing low-voltage condition.
 - d) Battery low voltage.
 - e) High ambient temperature.
 - f) Inverter fault.
 - g) Output fault.
 - h) Output overload.
- 3. Remote Signal Interfaces:
 - a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:
 - 1) Fault or status indication.
 - 2) On bypass.
 - 3) Low battery.
 - b. Communications Interface: Factory-installed hardware and software to enable a remote PC to monitor and display status and alarms.
 - 1) Communications Ports: RS-232.
 - 2) Network Communications Ports: Ethernet.
 - 3) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

G. Self-Protection and Reliability Features:

- 1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
- 2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.

3. Battery deep-discharge and self-discharge protection; with alarms.
 4. Battery self-test circuitry; with alarms and logging.
- H. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.
1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 65 kA.
- I. Rectifier:
1. Description: Solid state, with the following operational features:
 - a. Automatically convert incoming ac voltage to regulated dc bus voltage, with less than 2 percent rms ripple voltage with inverter fully loaded and batteries disconnected.
 - b. Rectified Efficiency: Not less than 97 percent.
 - c. Generator compatible.
- J. Inverter:
1. Description: Solid-state, high-frequency, PWM type, with the following operational features:
 - a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes, with recovery within 3 cycles.
 - b. Automatically regulate output frequency to within plus or minus 0.05 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
 - c. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
 - d. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.
 - e. Load Power Factor: 0.8 lead to 0.8 lag.
- K. Battery Charger:
1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
 2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
 3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.
- L. Batteries:
1. Description: Lithium-ion batteries.
 - a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.
 2. Battery Disconnect and OCPD: Manufacturer's standard.

M. Line Conditioning and Filtering:

1. Input Line Conditioning:
 - a. Provide input filtering, as required, to limit TDD and THD(V) at the defined point of common coupling per IEEE 519.
2. Output Voltage Waveform:
 - a. Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.

N. Maintenance Bypass Systems:

1. Maintenance Bypass Mode:
 - a. Internal; manual operation only; bypasses central battery equipment completely. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Bypass Overload Capability: 1.5 times the base load current.

2.2 ENCLOSURES

- A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.
1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
 2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.3 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate central battery equipment fabricator's quality-control and testing methods.
- B. Testing: Test and inspect central battery equipment according to UL 924.
- C. Factory Tests: Test and inspect assembled central battery equipment according to UL 924. Affix standards organization's label. Include the following:
1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
 2. Full-load test.
 3. Transient-load response test.
 4. Overload test.
 5. Power failure test.
- D. Central battery equipment will be considered defective if it does not pass tests and inspections.

- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store central battery equipment according to NECA 411.
- B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.
- C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install central battery equipment and accessories according to NECA 411.
- C. Floor-Mounted Central Battery Equipment: Install central battery equipment on 4-inch nominal-thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Comply with NECA 1.

F. Wiring Methods:

1. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters.
2. Conceal raceway and cables except in unfinished spaces.
3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

G. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 CONNECTIONS

- A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 INSTALLATION OF CONTROL WIRING

- A. Install wiring between central battery equipment and remote devices.
- B. Bundle, train, and support wiring in enclosures.

3.5 IDENTIFICATION

- A. Identify central battery equipment, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label central battery equipment with engraved nameplates.
 3. Label each separate cabinet, for multicabinet units.
 4. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform start-up, test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Acceptance Testing Preparation:
 - 1. Inspect and Test Each Component:
 - a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
 - b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
 - c. Test continuity of each circuit.
- E. Tests and Inspections:
 - 1. Inspect central battery equipment, wiring, components, connections, and equipment installation.
 - 2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
 - 3. Test continuity of each circuit.
 - 4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2. If outside this range, notify Construction Manager before closing input OCPDs.
 - 5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
 - 6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
 - 7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Central battery equipment will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, and other adjustable parts.
- C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.
- D. Set the automatic system test parameters.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 26 33 23.11

SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type 2 surge protective devices.
2. Enclosures.

B. Related Requirements:

1. Section 262413 "Switchboards" for integral SPDs installed by switchboard manufacturer.

1.2 DEFINITIONS

- A. I_n : Nominal discharge current.
- B. Maximum Continuous Operating Voltage (MCOV): The maximum designated RMS value of the power frequency voltage that may be continuously applied to the mode of protection of an SPD.
- C. Metal-Oxide Varistor (MOV): An electronic component with a significant bidirectional, nonlinear current-voltage characteristic.
- D. Mode(s), Modes of Protection, or Protection Modes: Electrical paths where the SPD offers defense against transient overvoltages. Examples include: line to neutral (L-N), line to ground (L-G), line to line (L-L), and neutral to ground (N-G).
- E. SCCR: Short-circuit current rating.
- F. Type 1 SPDs: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.
- G. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
- H. Type 3 SPDs: Point of utilization SPDs.
- I. Type 4 SPDs: Component SPDs, including discrete components, as well as assemblies.
- J. Type 5 SPDs: Discrete component surge suppressors, such as MOVs that may be mounted on a printed wiring board, connected by its leads or provided within an enclosure with mounting means and wiring terminations.
- K. Voltage Protection Rating (VPR): A rating selected from UL 1449 list of preferred values assigned to each mode of protection.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include electrical characteristics, specialties, and accessories for SPDs.
 - b. Certification of compliance with UL 1449 by qualified electrical testing laboratory recognized by authorities having jurisdiction including the following information:
 - 1) Tested values for VPRs.
 - 2) I_n ratings.
 - 3) MCOV, type designations.
 - 4) OCPD requirements.
 - 5) Manufacturer's model number.
 - 6) System voltage.
 - 7) Modes of protection.

1.4 INFORMATIONAL SUBMITTALS

- #### A. Sample Warranty: For manufacturer's special warranty.

1.5 WARRANTY

- #### A. Special Manufacturer Extended Warranty: Manufacturer warrants that SPDs perform in accordance with specified requirements and agrees to provide repair or replacement of SPDs that fail to perform as specified within extended warranty period.
1. Initial Extended Warranty Period: Five year(s) from date of Substantial Completion, for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

- #### A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB, Electrification Business.
 2. Eaton.
 3. Schneider Electric USA, Inc.
 4. Siemens Industry, Inc., Energy Management Division.
 5. Advanced Protection Technologies Inc. (APT).
 6. Current Technology Inc.
 7. Liebert; a brand of Emerson Electric Co.
 8. Mersen.
 9. Surge Suppression Inc.

- B. Source Limitations: Obtain devices from single source from single manufacturer.
- C. General Characteristics:
1. Reference Standards: UL 1449, Type 2; UL 1283.
 2. MCOV: Not less than 125 percent of nominal system voltage for 208Y/120 V and 120/240 V power systems, and not less than 115 percent of nominal system voltage for 480Y/277 V power systems.
 3. Peak Surge Current Rating:
 - a. Panelboards up to 225Amps: Equal or exceed 60kA Per Mode (120kA Per Phase).
 - b. Panelboards 226-800Amps: Equal or exceed 100kA Per Mode (200kA Per Phase).
 - c. Panelboards 801-1200Amps: Equal or exceed 150kA Per Mode (300kA Per Phase).
- D. Protection modes and UL 1449 VPR shall not exceed the following:

	480Y/277V, 3Ph, 4W Panelboards	480V, 3Ph, 3W Panelboards	208Y/120V, 3Ph, 4W Panelboards
Protection Modes	UL 1449 Voltage Protection Rating (VPR)		
L-N	1200	-	700
L-L	1800	1800	1200
L-G	1200	1800	700
N-G	1200	-	700

- E. SCCR: Equal or exceed 100 kA.
- F. I_n Rating: 20 kA.
- G. Discrete Modes of Protection, equal to:
1. 480Y/277V, 3-Phase, 4-Wire Panels: 7 or 10 Modes.
 2. 480V, 3-Phase, 3-Wire Panels: 6 Modes.
 3. 208Y/120V, 3-Phase, 4-Wire Panels: 7 or 10 Modes.
- H. Options:
1. Include LED indicator lights for power and protection status.

2.2 ENCLOSURES

- A. Indoor Enclosures: Type 1.

2.3 CONDUCTORS AND CABLES

- A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's instructions.
- B. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's instructions. Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
 - 1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
 - 2. Do not exceed manufacturer's recommended lead length.
 - 3. Do not bond neutral and ground.
- C. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's installation requirements.
- B. Nonconforming Work:
 - 1. SPDs that do not pass tests and inspections will be considered defective.
 - 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

- A. Complete startup checks in accordance with manufacturer's instructions.
- B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests; reconnect them immediately after the testing is over.
- C. Energize SPDs after power system has been energized, stabilized, and tested.

END OF SECTION 26 43 13

SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior LED luminaires
 - 2. Materials.
 - 3. Luminaire support.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Recessed luminaires shall comply with NEMA LE 4.
- C. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 - 1. Manufacturer's standard grade.
 - 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

2.3 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- D. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- E. Wall-Mounted Luminaires:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- F. Suspended Luminaires:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 26 51 19

SECTION 26 52 13 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exit signs.
2. Materials.
3. Luminaire support components.

B. Related Requirements:

1. Section 26 33 23.11 - Central Battery Equipment for Emergency Lighting for central lighting inverter supplying UL924 compliant emergency power to exit signs and emergency egress lighting.

1.2 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.
- B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
- C. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - a. Include data on features, accessories, and finishes.
 - b. Include physical description of unit and dimensions.
 - c. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - d. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.

B. Product Schedule:

1. For exit signs. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of luminaire.
- B. Sample Warranty: For manufacturer's warranty.

1.5 QUALITY ASSURANCE

- A. FM Global Compliance: Luminaires for hazardous locations must be listed and labeled for indicated class and division of hazard by FM Global.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

PART 2 - PRODUCTS

2.1 EMERGENCY EXIT SIGNS

- A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
 - 1. Options:
 - a. Operating at nominal voltage of 277 V(ac).
 - b. Lamps for AC Operation:
 - 1) LEDs; 50,000 hours minimum rated lamp life.

2.2 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components must be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 - 1. Smooth operating, free of light leakage under operating conditions.
 - 2. Designed to permit relamping without use of tools.
 - 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

2.3 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices must be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- C. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- D. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inch, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- E. Ceiling Grid Mounted Luminaires:

1. Secure to outlet box, if provided.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Owner's Representative.
- B. Tests and Inspections:
 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- C. Nonconforming Work:
 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
 2. Remove and replace defective units and retest.
- D. Prepare test and inspection reports.

3.5 SYSTEM STARTUP

- A. Perform startup service:

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 1. Inspect luminaires. Replace lamps, exit signs, and luminaires that are defective.
 - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

3.7 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

END OF SECTION 26 52 13

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Statement of Work: The work of this section includes, but is not necessarily limited to the following:
 - 1. Provide all materials and labor for the installation of a permanent Grounding and Bonding System for Telecommunications Infrastructure, including Pathways, Spaces, Equipment, Raceways, Enclosures, and Communications Circuits within the project areas of the building as per this document and the accompanying Drawings.
 - 2. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections
- B. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures, or codes as set forth by the authority having jurisdiction.
 - 4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:
 - 1. Section 27 05 28 Pathways for Communications Systems
 - 2. Section 27 05 29 Hangers and Supports for Communications Systems
 - 3. Section 27 05 36 Cable Trays for Communications Systems
 - 4. Section 27 11 00 Communications Equipment Room Fittings
 - 5. Section 27 11 16 Communications Racks, Frames and Enclosures
 - 6. Section 27 13 13 Communications Copper Backbone Cabling

1.4 RELATED WORK

- A. The Contractor shall coordinate with the Electrical Contractor and all other trades as needed on cable raceway and penetration locations for routing of cables required for the grounding and bonding system.
- B. Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are not limited to:
 - 1. Section 07 84 13 – Penetration Firestopping
 - 2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
 - 3. Section 26 05 29 – Hangers and Supports for Electrical Systems
 - 4. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.5 DEFINITIONS

- A. Regardless of their usage in codes or other industry standards certain words or phrases, as used in the Drawings and/or the Specifications, shall be understood to have the specific meanings as ascribed to them in the following list:
 - 1. Contractor – Term used for the Integrator or Installer who has been awarded the contract to perform work under this section that is applicable to both Electrical and/or Telecommunications.
 - 2. Electrical Contractor – Integrator or Installer who has been awarded the contract to perform the electrical work under this section.
 - 3. Telecommunications Contractor – Integrator or Installer who has been awarded the contract to perform the telecommunications work under this section.
 - 4. Shall is mandatory instruction.
 - 5. Will is informative.
 - 6. Should is advisory.
 - 7. Provide – To supply, install, connect, and configure, for safe intended normal operation.
 - 8. Indicated, Shown, or Noted – As indicated on drawings or specifications.
 - 9. Equivalent, Similar, or Equal – Equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
 - 10. Reviewed, Satisfactory, Accepted, Approved, and Directed – As reviewed and considered satisfactory, acceptable, approved, or directed by the Owner or Owner's Representative.
 - 11. EMT – Electrical Metallic Tubing.
 - 12. SMR – Surface Metal Raceway.
 - 13. Raceway – Any enclosed channel for routing wire, cable or TBB(s).
 - 14. PBB – Primary Bonding Busbar (previously Telecommunications Main grounding Busbar, TMGB). There is typically one PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
 - 15. SBB – Secondary Bonding Busbar (previously Telecommunications Grounding Busbar, TGB). There is typically one SBB per telecommunications room. The SBB is connected to the PBB.
 - 16. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBBs to SBBs.
 - 17. BBC – Backbone Bonding Conductor (previously Grounding Equalizer, GE). A telecommunications bonding connection that interconnects TBBs.
 - 18. TBC – telecommunications Bonding Conductor (previously Bonding Conductor for Telecommunications, BCT). Conductor that connects the telecommunications bonding infrastructure to the building's service equipment (power) ground.
 - 19. RBB – Rack Bonding Busbar. Copper busbar installed on and bonded to equipment rack or cabinet, used to bond installed equipment via TEBC.

- 20. RBC – Rack Bonding Conductor. A telecommunications bonding conductor connecting equipment racks or cabinets and RBBs to the PBB or SBB within a Telecommunications space.
- 21. TEBC – Telecommunications Equipment Bonding Conductor. A bonding conductor used to connect equipment to an RBB or RBC.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:

- 1. Systems shall be installed in accordance with the latest revisions of all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State, and Municipal Building Codes and the codes and standards of all other Authorities Having Jurisdiction
 - b. ASTM International (ASTM)
 - c. ASTM B3 Standard Specification for Soft or Annealed Copper Wire
 - d. ASTM B8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - e. ASTM B33 Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
 - f. ASTM E814 Standard Test Method for Fire Tests of Firestop Systems
 - g. International Code Council (ICC)
 - h. International Building Code (IBC) / BOCA National Building Code
 - i. Occupational Safety and Health Administration (OSHA)
 - j. Occupational Health and Safety Standards (Standards – 29 CFR)
- 2. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE C2 National Electric Safety Code (NESC)
 - b. IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System
 - c. IEEE 837 Standard for Qualifying Permanent Connections Used in Substation Grounding
- 3. National Fire Protection Agency (NFPA):
 - a. NFPA-70 National Electric Code (NEC)
 - b. NFPA-70B Recommended Practice for Electrical Equipment Maintenance
 - c. NFPA-72 National Fire Alarm and Signaling Code
 - d. NFPA 780 Standard for the Installation of Lightning Protection Systems
- 4. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250 Enclosures for Electrical Equipment (100 Volts Maximum)
- 5. Telecommunications Industry Association (TIA):
 - a. TIA 568.1-D Commercial Building Telecommunications Infrastructure Standard
 - b. TIA-569-D Telecommunications Spaces and Pathways
 - c. TIA 606-C Administration Standard for Telecommunications Infrastructure
 - d. TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for

Customer Premises

6. BICSI:
 - a. Telecommunications Distribution Methods Manual (TDMM), 13th Edition
 - b. Information Technology Systems Installation Methods Manual, 6th Edition
7. Underwriters Laboratory
 - a. UL 1 Standard for Flexible Metal Conduit
 - b. UL 5 Standard for Surface Metal Raceways and Fittings
 - c. UL 50 Standard for Enclosures for Electrical Equipment
 - d. UL 96 Standard for Lightning Protection Components
 - e. UL 360 Standard for Liquid-Tight Flexible Metal Conduit
 - f. UL 467 Grounding and Bonding Equipment
 - g. UL 486A, 486B Wire Connectors
 - h. UL 514A Metallic Outlet Boxes
 - i. UL 514B Conduit, Tubing, and Cable Fittings
 - j. UL 797 Electrical Metallic Tubing – Steel
 - k. UL 1479 Standard for Fire Tests of Penetration Firestops

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. System Summary: The Telecommunications Grounding and Bonding System shall be designed and installed in accordance with TIA 607-C and BICSI best practices.
- B. The following is for a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The Specifications and the Contract Drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.
- C. The Contractor shall provide Grounding and Bonding infrastructure that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code, and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.
- D. Materials:
 1. Furnish and install at locations that show the specified equipment to provide a completely operational Telecommunications Grounding and Bonding System without additional cost to the Owner.
 2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. Telecommunications Ground Bar(s)
 - b. Telecommunications Bonding Backbone Cabling
 - c. Exothermic Welds
 - d. Listed Lugs, Pressure Connectors, and Clamps
 - e. Ground Electrodes
 - f. Supports, Straps, and Installation Accessories

1.8 RELATED WORK

A. Pathways:

1. It is the Contractor's responsibility to review all existing designed Telecommunications Spaces and Pathways to ensure complete integration of the Grounding and Bonding System.
2. It is the Contractor's responsibility to review and ensure compatibility and safe, proper integration with the Building AC Electrical Grounding system and the Building Lightning Protection System.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, or after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
- C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.10 PROJECT SCHEDULE

- A. Project schedule shall follow the Division 0 (or equivalent) construction schedule.

1.11 BID/TECHNICAL PROPOSALS

- A. Bid proposal shall follow Division 0 (or equivalent), and the general contractor requirements for bidding.

1.12 SUBMITTALS

- A. In addition to the following, Submittals requirements shall follow Division 0 and the General Contractor requirements for submittals.
- B. Action Submittals:
 1. Product Data: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.
 2. For those items noted as "Or Equal" and which are not being provided as specifically named, submit standard cut sheets or other descriptive information, along with a separate written description detailing the reason(s) for the substitution.
 - a. Provide standard manufacturer's cut sheets at the time of submittal review for each indicated product in the system. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive said materials.

3. Shop Drawings: Submit shop drawings for approval prior to fabrication or installation. Include detailed plans, required clearances, installation methods, and accessories. Include any relationships with adjacent equipment and materials.

C. Closeout Submittals

1. As-Built Drawings: At the completion of the project, the contractor shall submit complete records to the Owner / Project Manager, reflecting any changes that occurred during the process of construction.
 - a. Records shall be maintained at the project site and shall consist of:
 - 1) A minimum of one set of As-Built Drawings with redline markups reflecting any changes or deviation from the system as initially shown on Contract Documents, and clearly identified component labels and identifiers.
 - 2) A minimum of one full set of Specifications with all Addenda.
 - 3) Any and all related spreadsheets or documentation.
 - b. Keep Records at the job site and make available to Owner and/or Designer at all times.
 - c. Keep Records current throughout the progress of construction. ("Current" is defined as not more than one (1) week behind actual construction).
 - d. Show identifiers for major infrastructure components on Drawings.
2. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
 - a. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.
 - b. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
 - c. Include recommended testing intervals.

1.13 PROJECT CONDITIONS

- A. Verify conditions on the jobsite applicable to this work. Notify General Contractor and/or Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

1.14 QUALITY ASSURANCE

- A. In addition to the following, Quality Assurance requirements shall follow Division 0 and the general contractor requirements for quality assurance.
- B. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Comply with NFPA 70, "National Electrical Code".

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Article 100 of NFPA 70, by an acceptable testing agency, and marked for intended use.
2. Comply with UL 467.

1.15 PRE-INSTALLATION MEETING/SCHEDULE

- A. If applicable, Pre-Installation meeting and schedule shall follow division 0 and the general contractor requirements for meeting attendance.

1.16 FINAL INSPECTION AND TESTING / COMMISSIONING

- A. Inspection and testing requirements shall follow Division 0 and the general contractor requirements for inspection.

1.17 WARRANTY

- A. Warranty requirements shall follow Division 0 and the general contractor requirements for warranties for materials and labor.
- B. Unless otherwise specified, provide a Contractor-endorsed warranty against defects in materials and workmanship.
1. Provide one year on site labor warranty.
 2. Provide 20-year material warranty.
 3. The Contractor Warranty period shall initiate upon equipment installation at the site.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All material shall be new unless otherwise noted in this specification.
- B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

- A. The sizes and quantities of all conductors, accessories, and materials shall be determined and installed by the Contractor based on the requirement to provide a complete grounding and bonding solution.
- B. For insulated conductors, comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. All Telecommunications Grounding and Bonding Materials shall be copper, unless otherwise

specified.

- D. Equipment Grounding Conductors shall be insulated with green-colored insulation.
- E. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- F. Grounding Electrode Conductors: Stranded copper cable.

2.3 PRODUCTS

- A. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
- B. Copper Bonding Conductors for Communications: As follows:
 - 1. TBC- from PBB to service equipment ground (power): minimum 3/0 AWG insulated copper conductor.
 - 2. TBB minimum 3/0 AWG insulated copper conductor or as per TIA 607-C.
 - 3. Bonding Conductor (between PBB and SBB(s) and electrical ground: minimum 3/0 AWG insulated copper conductor.
 - 4. Overhead Bonding Conductor (MDF): minimum 2 AWG insulated copper conductor.
 - 5. Equipment Bonding Conductors: minimum 6 AWG insulated copper conductor.
- C. Grounding Bus Bars
 - 1. Shall be bare, annealed copper bars of rectangular cross section, with insulators as shown on drawings.
 - a. Primary Bonding Bus Bar (PBB) in MDF:
 - 1) (20" x 4" x 1/4"), Pre-drilled: CPI 40153-020
 - 2) (20" x 4" x 1/4"), Pre-drilled: HUBBELL HBBB14420J
 - 3) Or approved equal
 - b. Secondary Bonding Bus Bar (SBB) in IDF:
 - 1) (10" x 4" x 1/4"), Pre-drilled: CPI 40153-012
 - 2) (10" x 4" x 1/4"), Pre-drilled: HUBBELL HBBB14210A
 - 3) Or approved equal
- D. Connector Products
 - 1. Comply with IEEE 837 and UL 467.
 - 2. Listed for use for specific types, sizes, and combinations of conductors and connected items.

E. Bolted Connectors:

1. UL Listed
2. Tin-plated copper connector.
3. Two-hole, long barrel compression type with window lug.
4. Code or Flex, as required.

F. HTAP Connector

1. UL Listed
2. Tin-plated copper connector.
3. For use with parallel or multiple tap connections.
4. Compression type with separated tap grooves for independent use.
5. Code or Flex, as required.
6. Include clear cover.

G. Welded Connectors:

1. Exothermic-welded types, in kit form, and selected per manufacturer's written instructions
 - a. CAD Weld
 - b. Or approved equal

H. Firestopping Material:

1. Must conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted testing agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of actual field conditions.
2. Firestopping material that is used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
3. Fire stopping material may be a re-entry mechanical system.
4. Acceptable Manufacturers:
 - a. Hilti
 - b. 3M
 - c. EZ Path
 - d. Or approved equal

I. Labels:

1. As recommended in TIA 606-C.
2. Permanently fastened.
3. Factory printed or created by hand-carried label maker or a software-based label making system.
4. Handwritten labels are not acceptable.
5. Acceptable materials:
 - a. Panduit Telecommunications Grounding and Bonding Conductor Label Kit
 - b. Brady ID Pro Plus with Wire Marking Labels WML-511-292
 - c. Or approved equivalent

PART 3 EXECUTION

3.1 GENERAL

- A. Install a grounding and bonding system in a manner ensuring that telecommunications circuits, equipment, enclosures, raceways, and components, when installed, can fully comply with the NEC, TIA, BICSI, and other references listed in these specifications.
- B. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes, and ordinances.
- C. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- D. All work shall comply with the standards, references, and codes listed above in Section 1.6 of this document. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- E. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- F. Install grounding and bonding system in a manner ensuring that telecommunications circuits, equipment, enclosures, raceways, and components, when installed, can fully comply with the NEC, TIA, BICSI, and other references listed in these specifications.
- G. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during construction at no additional cost to the Owner.
- H. Remove surplus material and debris from the job site and dispose of legally.

3.2 EXAMINATION

- A. Examine surfaces for compliance with installation tolerances and other conditions affecting performance of grounding and bonding component installation. Do not proceed with installation until insufficient conditions have been amended.

3.3 APPLICATION

- A. Use only copper conductors for both insulated and bare grounding conductors.
- B. In raceways, use insulated equipment-grounding conductors.
- C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- D. PBB/SBB: Install in Telecommunications Entrance Facilities, Telecommunications Equipment Rooms, Telecommunications Rooms, Telecommunications Spaces, and elsewhere as indicated.
 - 1. Use insulated spacer; space 2 inches from wall and support from wall 96 inches above

- finished floor, unless otherwise indicated.
2. TBB: Provide TBB(s) as applicable on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment to the nearest SBB if the direct bonding method is not employed. Use TBB(s) to connect the PBB to each of the SBB(s) if the legacy telecom (TBB) bonding method is employed. The Contractor shall route along the shortest and straightest path possible with minimum bends. All bends shall be sweeping. TBB(s) shall be continuous (without splices).
 3. Install the TBB without splices where practical. When splices are necessary, they shall be minimal in quantity, accessible, and located in telecommunications spaces.
 4. The bonding conductor for communications shall bond components, equipment and cable sheaths.
 5. PBB: Provide a minimum of one PBB per Telecommunications Entrance Facility (EF) for each building. Install PBB(s) and directly bond PBB(s) to the verified electrical service ground and to the related TBB(s) if a legacy TBB is employed.
 6. Install the PBB in the Telecommunications Entrance Facility (EF) such that it is accessible to telecommunications and building facilities personnel
 7. SBB: Provide a minimum of one SBB per Telecommunications Room (TR), as shown on the Contract Documents, and as required by standards, references and codes listed above in Section 1.6 of this document. Directly bond each SBB to a dedicated structural steel ground lug within the space and/or to its related TBB.
 8. The TBB and any telecommunications grounding bus bars within the same space shall be bonded to the SBB with a grounding conductor that is not less than 2/0 AWG. It shall be an insulated copper conductor. Routing shall be continuous, short, and as straight as possible.
 9. Do not use interior water piping system, metallic cable shield, metallic conduit, trunking, cable tray, or cable ladder as a TBB.
 10. The TBB is a dedicated conductor.

3.4 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Comply with TIA 607-C.
- C. For alarm, voice, data, and other communication systems, provide an insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, telecommunications rooms, and central equipment location.
 1. Terminate grounding conductor on a minimum 1/4" x 4" x 12" grounding bus.
 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding bus bar/terminal.
- D. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor and install in conduit.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise

indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- C. When bonding to painted surfaces, remove paint at contact location and use antioxidant paste, or use paint-piercing bonding washers and antioxidant paste.
- D. Metal Water Service Pipe: Do not connect to communications ground system.
- E. Water Meter Piping: Do not connect to communications ground system.

3.6 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturers written instructions. Welds that are puffed up or that show convex surface indicating improper cleaning are not acceptable. Refer to Division 26 Section 260526 "Grounding and Bonding for Electrical Systems" for acceptable locations for exothermic-welded connections.
- C. Equipment Grounding Conductor Terminations: For 6 AWG and larger, use pressure-type grounding lugs. 6 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Screws and Bolts for Grounding and Bonding Connectors and Terminals: Tighten according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor. Use only two-hole lugs for connections to PBB and SBB. Refer to Division 26 Section 260526

"Grounding and Bonding for Electrical Systems" for acceptable locations for compression-type connections.

- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.7 FIRESTOPPING:

- A. The Telecommunications Contractor shall maintain the fire rating of all penetrated fire barriers. Firestop and seal all penetrations made during the SCS installation.
 - 1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
 - 2. Install firestops in strict accordance with manufacturer's detailed installation procedure.
 - 3. Install firestops in accordance with fire resistance requirements, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in PART 1-1.2 REFERENCES. Apply sealing material in a manner acceptable to the local fire and Authority Having Jurisdiction (AHJ).

3.8 LABELING:

- A. Label Telecommunications Grounding and Bonding Components in accordance with TIA 606-C:
 - 1. Label PBB(s) with "PBB", [number] per TIA 606-C
 - 2. Label SBB(s) with "SBB", [number] per TIA 606-C
 - 3. Label TBB(s) with "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.9 FIELD QUALITY CONTROL

- A. Testing:
 - 1. Perform the following field quality-control testing:
 - a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
 - b. Perform visual inspection of all existing and installed bonding components.
 - c. Perform voltage test to ensure the absence of ground faults travelling through Telecommunications Bonding System.
 - d. Prior to installation of any Telecommunications equipment, perform two-point ground testing:
 - 1) Between PBB (MDF) and nearest electrical grounding electrode.
 - 2) Between PBB (MDF) and existing building PBB.
 - 3) Between SBB (IDFs) and nearest electrical grounding electrode.
 - 4) Between SBB (IDFs) and nearest existing building SBB.
 - 5) Between other points in the Telecommunications Bonding System, as necessary.
 - e. The maximum value for resistance between any of the points listed above shall be

100 milliohms.

3.10 CONSULTANT ACCEPTANCE TESTS

- A. Owner's Representative and/or consultant shall approve grounding and bonding testing / inspection reports.
- B. Final Owner's Representative and/or consultant acceptance will be performed along with the acceptance of completed telecommunications systems.

END OF SECTION 27 05 26

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation

1.2 SUMMARY

- A. Statement of Work: The work of this section includes, but is not necessarily limited to the following:
1. Provide all materials and labor for the installation of a permanent Communications Pathway System as hereinafter identified and/or reflected per this document and the accompanying drawings.
- B. Communication Pathways are defined to include but are not limited to horizontal and building backbone raceways, fittings and boxes, conduit, pull boxes, sleeves, cable trays, ladder rack, supports, accessories, associated hardware, and fire stopping materials specific to cabling for voice and data.
- C. The primary horizontal cable support system will be a cable tray, installed as shown in the TN drawings. The cable tray will be properly grounded. Wall penetrations shall transition to properly fire-stopped 1" - 4" sleeves, then back to cable tray.
- D. Work furnished and installed by Contractor as specified in this Section and as shown in the TN drawings includes:
1. Equipment/Telecommunications Rooms- Cable tray and ladder rack installation.
 2. Overhead- Backbone and Horizontal Communication Pathways.
 3. Work Area Outlets – Conduits and back boxes.
 - a. Work Area Outlets having one single cable require a single gang box that stubs up into the ceiling void facing the nearest cable tray via one (1) 1" conduit with pull string.
 - b. Work Area Outlets having two to six cables require a double gang box with a single gang reducer that stubs up into the ceiling void via one (1) 1" conduit with pull string.
 - c. Conduit runs may not be longer than 100' or have more than two 90-degree bends without the use of a properly sized junction box.
 - d. Insulated throat compression fittings must be used for communications conduit runs, with termination points having plastic or grounding bushings installed.
 - e. Minimum radii for conduit bends shall be as follows:
 - 1) Internal diameter of less than two (2) inches is 6 times the internal diameter.
 - 2) Internal diameter of more than two (2) inches is 10 times the internal diameter.

4. The floor poke through hardware.
5. Fire stopping of cable tray and conduit cable pathways.
6. Bonding and grounding of overhead cable pathway system- cable tray/ladder rack, racks, and cabinets within the ER/TRs.

- E. Completely coordinate with work of other trades.

1.3 SECTION INCLUDES

- A. Interior communications pathways and supports.
- B. Outlet and conduit runs.
- C. Risers in ER/TR(s).
- D. Grounding and bonding of pathways.
- E. Pathway fire stopping requirements

1.4 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 1. 27 05 26 Grounding and Bonding for Communications Systems
 2. 27 05 29 Hangers and Supports for Communications Systems
 3. 27 05 36 Cable Trays for Communications Systems

1.5 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

- A. The pertinent portions of the following specifications, standards, regulations and codes shall be incorporated by reference into these specifications.
 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - d. NEMA VE 1 – Metallic Cable Tray Systems
 - e. NEMA VE 2 – Cable Tray Installation Guidelines
 2. Communications:
 - a. TIA 568.1-D Commercial Building Telecommunications Infrastructure Standard
 - b. TIA 569-D Telecommunication Spaces and Pathways
 - c. TIA 606-C Administration Standard for Telecommunications Infrastructure
 - d. TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for

- Customer Premises
- e. BICSI TCIM: BICSI Telecommunications Cabling Installation Manual
 - f. BICSI TDMM: BICSI Telecommunications Distribution Methods Manual

1.6 DEFINITIONS

- A. "EMT" shall mean Electrical Metallic Tubing.
- B. "Raceway" shall mean any enclosed channel for routing wire, cable or busbars.
- C. PBB – Primary Bonding Busbar (previously Telecommunications Main grounding Busbar, TMGB). There is typically one PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- D. SBB – Secondary Bonding Busbar (previously Telecommunications Grounding Busbar, TGB). There is typically one SBB per telecommunications room. The SBB is connected to the PBB.
- E. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBBs to SBBs.
- F. BBC – Backbone Bonding Conductor (previously Grounding Equalizer, GE). A telecommunications bonding connection that interconnects TBBs.
- G. TBC – telecommunications Bonding Conductor (previously Bonding Conductor for Telecommunications, BCT). Conductor that connects the telecommunications bonding infrastructure to the building's service equipment (power) ground.
- H. RBB – Rack Bonding Busbar. Copper busbar installed on and bonded to equipment rack or cabinet, used to bond installed equipment via TEBC.
- I. RBC – Rack Bonding Conductor. A telecommunications bonding conductor connecting equipment racks or cabinets and RBBs to the PBB or SBB within a Telecommunications space.
- J. TEBC – Telecommunications Equipment Bonding Conductor. A bonding conductor used to connect equipment to an RBB or RBC.
- K. "Junction Box" shall mean a pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. Furnish, install, and place into adequate and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Communications Pathways System for Telecommunications Circuits as specified in the Contract Documents. The Communications Pathways System shall support an ANSI/TIA/EIA and ISO/IEC compliant telecommunications Structured Cabling System (SCS).

1.8 SUBMITTALS INFORMATION

- A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.
- B. Closeout Submittals:
 - 1. Records- Maintain at the project site a minimum of one set of Drawings, Specifications, and Addenda. Drawings shall consist of redline markups, specifications, and spreadsheets.
 - a. Document changes to the system from that initially shown from the Contract Documents, and clearly identify component labels and identifiers on Drawings.
 - b. Keep Drawings current throughout the progress of construction. "Current" is defined as not more than one (1) week behind actual construction.

PART 2 PRODUCTS

2.1 GENERAL

- A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, barrier strips, radius drops, bonding conductors, and other incidentals and accessories as required for a complete, permanent Communications Pathway System. Provide all incidental and or miscellaneous hardware not explicitly shown in the Contract Documents but that is required for an operational system.
- B. Physically verify existing site conditions prior to purchase and delivery of materials.
- C. Communications Pathways System components must be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.

2.2 MATERIALS AND FINISH

- A. Cable Tray (Welded Wire): Cable Tray shall be constructed of a welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all tray supports, materials, and supplementary and miscellaneous hardware required for a complete cable tray system.
 - 1. Finish: Carbon steel with electro-plated zinc galvanized finish.
 - 2. Width: Width shall be as shown on the Contract Documents. Where cable tray width is not shown in the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown in the Contract Documents) plus an additional 100% for future expansion.
 - 3. Depth: Maximum of two (2) inches.
 - 4. Mesh: 2 x 4 inches.
 - 5. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with the manufacturer's instructions.
 - 6. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.

- B. Ladder Rack: (Telco Style) Ladder rack shall be manufactured from tubular steel. Stringers (sides) will be made from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness. Cross members (rungs) will be made from 1" wide by 1/2" high tubular steel with .065" wall thickness
1. Ladder rack (stringers) will be 9'-8 1/2" long. Cross members will be welded in between stringers on 9" centers beginning 4-1/4" from one end so that there are thirteen cross members per ladder rack. There will be 8" of open space in between each cross member.
 2. Ladder rack will be UL Classified for suitability as an equipment-grounding conductor only. Minimum combined cross-sectional area of the stringers will be 0.40 square inches. A label affixed to the side stringer of the ladder rack will identify the manufacturer, the UL Classification and the minimum combined cross-sectional area of the stringers.
 3. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, ladder rack shall be complete with bolted splicing hardware for grounding/bonding throughout the entire system.
- C. Conduit and Fittings: For each communication outlet indicated, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, and other components and accessories as needed to form a complete system of the same type indicated.
- D. Wall and Ceiling Outlet Boxes: All wall outlets shall be mounted in a minimum four (4)-inch by four (4)- by two and one half (2 1/8) inch deep double gang outlet box with a single gang mud ring and furnished with a pull string. Outlet box accessories as require for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations.
- E. Pull/Junction Boxes: Pull boxes used with telecommunications conduits in interior locations shall be rated NEMA-1. Pull boxes used in damp or wet locations such as plumbing chases or outdoors shall be rated NEMA-3R. Pull boxes shall be installed in conduit runs at an interval of no greater than every 100 feet. A pull box shall be installed in conduit runs whenever there are two 90-degree sweeps, or a total of 180-degree sweeps in a conduit run. A pull box may not be used to change the direct ion of a conduit run.

2.3 FIRESTOPPING MATERIALS

- A. Firestopping Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL1479 fire test in a configuration that is representative of the actual field conditions.

2.4 LABELING AND ADMINISTRATION

- A. Labels: As recommended in TIA 606-C. Permanent (i.e. not subject to fading or erasure), permanently affixed and created by hand carried label maker or a computer/software-based label making system. Handwritten labels will not be acceptable.

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes, and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and or regulations are more stringent, in which case the local codes and or regulations shall govern.
- C. All work shall comply with the standards, references, and codes listed above in Article 1.5 REFERENCES. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to Owner.
- F. Install the communications pathways system in a manner ensuring that telecommunications circuits, when installed, can fully comply with the ANSI/TIA/EIA and other references listed above in Article 1.5 REFERENCES.
- G. Remove all surplus material and debris from job site and dispose of them legally.

3.2 INSTALLATION

- A. Provide cable trays above suspended ceilings in corridors and as shown on the Contract Documents and in the MDF and IDF rooms for backbone cabling and horizontal distribution.
- B. Cable trays shall be hung trapeze style. A center hung tray is unacceptable. The inside of the cable tray or wire way shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that cable can be pulled without physical damage. When a wire way passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors and ceilings shall be properly fire stopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wire ways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.
- C. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft.) on each side of any connection to a fitting. Wire ways shall be supported on 1500 mm (5 ft.) centers unless designed for greater lengths.
- D. Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical

installation practices.

1. Cable tray shall be installed plumb, level, and square with finished building surfaces.
2. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
3. Cable tray elevation changes shall be gradual.

E. Cable Tray Routing:

1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous, or corrosive areas.

F. Cable Tray Clearance Requirements:

1. Clearance requirements for cable tray accessibility:
 - a. Maintain a clearance of 6" between top of cable tray and ceiling structure or other equipment or raceway.
 - b. Maintain a clearance of 8" between at least one side of cable tray and nearby objects.
 - c. Maintain a clearance of 6" between bottom of cable tray and ceiling grid or other equipment or raceway.
2. Clearance requirements from sources of electromagnetic interference (EMI):
 - a. Maintain a clearance of 6" or more from fluorescent lighting.
 - b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
 - c. Maintain a clearance of 48" or more from motors or transformers.
 - d. Pathways shall cross perpendicularly to electrical power cables or conduits.
3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot- water pipes or other heat sources operating at temperatures above 100 degrees Fahrenheit.

G. Cable Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer's instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.

H. Cable tray supports shall be provided according to the manufacturer's recommendations.

1. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
2. Where cable trays abut walls, provide wall-mounted supports.
3. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
4. Trays shall be supported at 5-foot intervals minimum, or more frequently if required by the manufacturer.

- I. Load Span Criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.
- J. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.
- K. Wire-type cable tray shall be cut with a manufacturer-approved cutter with “offset cutting blade” jaws and a minimum 24-inch handle.
 - 1. The choice and position of the jaws at the point where the cut is made shall allow shearing as close as possible to the intersection of the steel wires.
 - 2. Cuts shall ensure the integrity of the galvanic protective layer.
- L. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are explicitly approved for bonding.
- M. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and during normal occupancy and operation.
- N. Barrier Strips: Provide barrier strips as recommended by manufacturer.
- O. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.
- P. Slots/Sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide hammer drilling, core drilling, and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.

3.3 GROUNDING AND BONDING

- A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in Article 1.5 REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Bond metallic raceway (including cable tray) together and to the nearest PBB/SBB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
- C. Cable Tray Bonding Splices: Provide cable tray splices according to manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.
- D. Bonding Conductors:
 - 1. Bond distribution conduits to cable tray.
 - 2. Provide bonding jumpers at expansion joints, sleeves, and any other locations where electrical continuity is interrupted.
 - 3. Provide bonding conductor between cable tray and the electrical power distribution system

grounding infrastructure.

3.4 FIRESTOPPING

- A. Only employees trained/certified by the fire-stopping manufacturer shall apply fire-stopping materials.
- B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
 - 1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
 - 2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
 - 3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in Article 1.5 REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
 - 4. For demolition work, apply fire stopping to open penetrations in fire rated barriers where cable is removed. Apply fire stopping regardless of whether the penetrations are used for new cable or left empty after construction is complete.
 - 5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/ re-enterable.

3.5 CLEANING AND PROTECTION

- A. After completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

1.1 LABELING AND ADMINISTRATION

- B. Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray:
 - 1. Label #1: Label shall read "TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY".
 - 2. Label #2: Label shall read "WARNING! CABLE TRAY SERVES AS A

HENRY ADAMS, LLC
February 28, 2022
GPO Project Number: 040ADV-20-C-0412
100% Final Construction Documents

SID Building D
Press Room Renovation
735 North Capitol Street, NE
Washington, DC 20401

TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!"

END OF SECTION 27 05 28

SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Support structures are necessary to allow installation of telecommunications cable, connecting hardware, and associated apparatus. These structures comprise components such as equipment racks, cabinets, distribution rings, hangers, J Hooks, plywood backboard, cable trays, conduits, slots, sleeves, and their associated hardware.
- B. Statement of Work: The work of this section includes, but is not necessarily limited to the following:
 - 1. Provide all materials and labor for the installation of a complete structured cabling hanger and support system including all cable trays, j-hooks, channels, wireways, etc. for telecommunications inside plant cable distribution per this document and the accompanying drawing package.
 - 2. This includes building backbone and horizontal cable tray raceways, fittings, and supports specific to cabling for Telecommunications systems.
 - 3. Completely coordinate with work of other trades.
 - 4. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.
- C. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the authority having jurisdiction.
 - 4. Submittal information and provisions.
- D. This section shall govern the products and installation of hangers and supports for communications systems.

1.3 RELATED DOCUMENTS

- A. The latest versions of the following codes, standards, and guidelines shall be followed.
- B. The following codes, as required by law:

1. National Electric Code (NEC)
 - C. The following standards:
 1. TIA-569-D Telecommunications Spaces and Pathways
 2. NECA/BICSI 568-2006, Installing Commercial Building Telecommunications Cabling
 - D. The following guidelines:
 1. BICSI, Telecommunications Distribution Methods Manual (TDMM)
 2. BICSI, Information Transport Systems Installation Methods Manual (ITSIMM)
- 1.4 SUBMITTALS
- A. In addition to the following, Submittals requirements shall follow Division 0 and the General Contractor requirements for submittals.
 - B. Action Submittals:
 1. Product Information
 - a. out.
 2. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled Shop Drawings
 - a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support (where supported by cable tray vs. j-hooks). These locations are to be fully coordinated with all other trades.
 - C. The following submittals are due Post-Construction:
 1. Record Drawings
 - a. In conjunction with horizontal and backbone cable routing, provide scaled drawings (not less than 1/8" = 1'-0") indicating routing of cable and means of support. Design drawings or shop drawings modified in the field will not be accepted.
 2. Manufacturer and Maintenance Manuals for all installed equipment.
 - a. Provide manufacturer's product information cutsheet or specifications sheet with the specific product number identified or filled out.

PART 2 PRODUCTS

2.1 CABLE HOOKS (J-HOOKS)

- A. Cable hooks shall:

1. Be listed by a NRTL for installation into a plenum space.
2. Be specifically designed for telecommunications cables.
3. Bear a surface of sufficient width to comply with required bend radii of high- performance cables.
4. Have flared edges to prevent damage while installing cables.
5. Include a top latch to keep cable within the hook. The cable retainer strap shall be removable and reusable and be suitable for use in air handling spaces.

B. Cable support sling shall:

1. Be constructed from steel and woven laminate.
2. Have a static load limit of 100 lbs.

C. Manufacturer shall be:

1. Cooper B-Line, BCH Series
2. Erico, Cablecat Series
3. Panduit, J-Pro Series
4. Or approved equivalent

PART 3 EXECUTION

3.1 GENERAL

- A. Follow all manufacturers' instructions.
- B. Coordinate with all other trades prior to installation.
- C. All telecommunications cabling not routed through conduit or cable tray shall be supported every 60" or less.
- D. Telecommunications cables shall not be supported by any other trades and shall be fully supported by independent methods.

3.2 CABLE HOOKS (J-HOOKS)

- A. Cable hooks shall not be supported by ceiling grid support wires.
- B. Where support wires are used, independent support wires shall be attached to the structural ceiling (above floor deck) on one end and to the suspended ceiling grid on the other end. The prior is meant to carry the load, the latter is meant to act as a "sway control".
- C. Size cable hooks to allow for a maximum of 25% capacity to facilitate future installation of cables.
- D. Cable hooks shall be installed such that cable slack between supports is a minimum of 6" above ceilings.
- E. Provide adequate cable hooks to ensure telecommunications cabling is a minimum of 6" from light fixtures and power conduits.

- F. Where telecommunications cabling is being supported with cable hooks, provide a cable hook at every change in direction.
- G. Cable hooks shall be installed in a conveniently accessible location.
- H. Route cabling such that a minimum of 48" is provided between cabling and electric motors or generators.

END OF SECTION 27 05 29

SECTION 27 05 36 – CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Provide all materials and labor for the installation of a permanent Cable Tray System as hereinafter identified and/or reflected per this document and the accompanying drawings.
- B. Cable Tray Systems are defined to include but are not limited to horizontal and building backbone cable trays, ladder rack, supports, accessories, associated hardware and fire stopping materials specific to cabling for voice and data.
- C. The primary horizontal cable support system will be a cable tray installed as shown in the TN drawings. Cable tray will be properly grounded. Wall penetrations shall transition to properly fire-stopped 1"- 4" sleeves, then back to cable tray.
- D. Work furnished and installed by Electrical Contractor as specified in this Section and as shown in the TN drawings includes:
 - 1. Equipment/Telecommunications Rooms- cable tray and ladder rack installation.
 - 2. Overhead- Backbone and Horizontal Communication Pathways.
 - 3. Fire stopping of cable tray and conduit cable pathways.
 - 4. Bonding and grounding of overhead cable pathway system- cable tray/ladder rack, racks, and cabinets within the ER/TRs.
- E. Completely coordinate with work of other trades.

1.3 SECTION INCLUDES

- A. Interior communications pathways and supports.
- B. Risers in ER/TR(s).
- C. Grounding and bonding of cable tray and components.
- D. Cable Tray Pathway fire stopping requirements.

1.4 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 26 Grounding and Bonding for Communications Systems
 - 2. 27 05 28 Pathways for Communications Systems
 - 3. 27 05 29 Hangers and Supports for Communications Systems

1.5 REFERENCE STANDARDS, REFERENCE MATERIALS, AND/OR CODES

- A. The pertinent portions of the following specifications, standards, regulations, and codes shall be incorporated by reference into these specifications.
 - 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 - d. NEMA VE 1 – Metallic Cable Tray Systems
 - e. NEMA VE 2 – Cable Tray Installation Guidelines
 - 2. Communications:
 - a. TIA-568.1D Commercial Building Telecommunications Infrastructure Standard.
 - b. TIA-569-D Telecommunication Spaces and Pathways.
 - c. TIA-606-C Administration Standard for Telecommunications Infrastructure.
 - d. TIA-607C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 - e. BICSI TCIM: BICSI Telecommunications Cabling Installation Manual.
 - f. BICSI TDMM: BICSI Telecommunications Distribution Methods Manual.

1.6 DEFINITIONS

- A. PBB – Primary Bonding Busbar (previously Telecommunications Main grounding Busbar, TMGB). There is typically one PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
- B. SBB – Secondary Bonding Busbar (previously Telecommunications Grounding Busbar, TGB). There is typically one SBB per telecommunications room. The SBB is connected to the PBB.
- C. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBBs to SBBs.
- D. BBC – Backbone Bonding Conductor (previously Grounding Equalizer, GE). A telecommunications bonding connection that interconnects TBBs.
- E. TBC – telecommunications Bonding Conductor (previously Bonding Conductor for Telecommunications, BCT). Conductor that connects the telecommunications bonding infrastructure to the building's service equipment (power) ground.

- F. RBB – Rack Bonding Busbar. Copper busbar installed on and bonded to equipment rack or cabinet, used to bond installed equipment via TEBC.
- G. RBC – Rack Bonding Conductor. A telecommunications bonding conductor connecting equipment racks or cabinets and RBBs to the PBB or SBB within a Telecommunications space.
- H. TEBC – Telecommunications Equipment Bonding Conductor. A bonding conductor used to connect equipment to an RBB or RBC.
- I. “Pullbox” shall mean a metallic box with a removable cover, used to assist pulling cable through conduit runs longer than 100’ or in which there are more than 180 degrees of bends. Pull boxes shall have no more than one (1) conduit entering and one (1) conduit exiting the box.
- J. “Junction Box” shall mean a pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

1.7 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. The following is a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The Specifications and the Contract Drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.
- B. Furnish, install, and place into adequate and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray Infrastructure for Telecommunications Circuits as specified in the Contract Documents. The Cable Tray System shall support an ANSI/TIA and ISO/IEC compliant Telecommunications Structured Cabling Systems.
- C. The work shall include materials, equipment, and apparatus not explicitly mentioned herein or noted in the Contract Document, but which are essential to make a complete working ANSI/TIA and ISO/IEC compliant Cable Tray System.
- D. Materials:
 - 1. Furnish and install at locations that show the specified equipment to provide a completely operational Telecommunications Cable Tray Distribution System without additional cost to the Owner.
 - 2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. Cable Tray Sections
 - b. Connectors and Fittings
 - c. Radius Drops
 - d. Pull Boxes
 - e. Hangers, supports, straps, and installation accessories for cable tray.

1.8 RELATED WORK

- A. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays as specified in part within this specification and associated drawing set.

1.9 SUBMITTALS INFORMATION

- A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.
- B. Closeout Submittals:
 1. Records- Maintain at the project site a minimum of one set of Drawings, Specifications, and Addenda. Drawings shall consist of redline markups, specifications, and spreadsheets.
 - a. Document changes to the system from that initially shown from the Contract Documents, and clearly identify component labels and identifiers on Drawings.
 - b. Keep Drawings current throughout the progress of construction. "Current" is defined as not more than one (1) week behind actual construction.

PART 2 PRODUCTS

2.1 GENERAL

- A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, barrier strips, radius drops, bonding conductors, and other incidentals and accessories as required for a complete, permanent Cable Tray for Communications System. Provide all incidental and/or miscellaneous hardware not explicitly shown in the Contract Documents but that is required for an operational system.
- B. Physically verify existing site conditions prior to purchase and delivery of materials.
- C. Cable Tray components must be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
- D. For a given manufacturer, all components shall be part of a single cable tray product line- components shall not be intermixed between a manufacturer's cable tray product lines unless otherwise specified.
- E. Cable Tray must be UL Classified if used as an equipment grounding conductor.

2.2 MATERIALS AND FINISH

- A. Cable Tray (Welded Wire): Cable Tray shall be constructed of a welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all tray supports, materials, and supplementary and miscellaneous hardware required for a complete cable tray system.
 1. Finish: Carbon steel with electro-plated zinc galvanized finish.

2. Width: 12" or as indicated on drawings. Where cable tray width is not shown in the Contract Documents, it shall be sized according to the amount of cable to be placed in the trays (as shown in the Contract Documents) plus an additional 100% for future expansion.
 3. Depth: Minimum of two (2) inches.
 4. Mesh: 2 x 4 inches.
 5. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with the manufacturer's instructions.
 6. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.
- B. Ladder Rack: (Telco Style) Ladder rack shall be manufactured from tubular steel. Stringers (sides) will be made from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness. Cross members (rungs) will be made from 1" wide by 1/2" high tubular steel with .065" wall thickness.
1. Ladder rack (stringers) will be 9'-8 1/2" long. Cross members will be welded in between stringers on 9" centers beginning 4-1/4" from one end so that there are thirteen cross members per ladder rack. There will be 8" of open space in between each cross member.
 2. Ladder rack will be UL Classified for suitability as an equipment-grounding conductor only. Minimum combined cross-sectional area of the stringers will be 0.40 square inches. A label affixed to the side stringer of the ladder rack will identify the manufacturer, the UL Classification and the minimum combined cross-sectional area of the stringers.
 3. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, ladder rack shall be complete with bolted splicing hardware for grounding/bonding throughout the entire system.

2.3 FIRESTOPPING MATERIALS

- A. Firestopping Material: Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL1479 fire test in a configuration that is representative of the actual field conditions.

2.4 LABELING AND ADMINISTRATION

- A. Labels: As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed and created by hand carried label maker or a computer/software-based label making system. Handwritten labels will not be acceptable.

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes, and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or

regulations shall govern.

- C. All work shall comply with the standards, references, and codes listed above in Article 1.5 REFERENCES. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to Owner.
- F. Install the communications pathways system in a manner ensuring that telecommunications circuits, when installed, are able to fully comply with the ANSI/TIA and other references listed above in Article 1.5 REFERENCES.
- G. Remove all surplus material and debris from job site and dispose of them legally.

3.2 INSTALLATION

- A. Provide cable trays above suspended ceilings in corridors and as shown on the Contract Documents and in the MDF and IDF rooms for backbone cabling and horizontal distribution.
- B. Cable trays shall be hung trapeze style. A center hung tray is unacceptable. The inside of the cable tray or wire way shall be free of burrs, sharp edges, or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) shall have the portion within the tray protected with a smooth, non-scratching covering so that cable can be pulled without physical damage. When a wire way passes through a partition or wall, it shall be an unbroken length. Installation of telecommunications cables shall not exceed the fill requirements. Openings in fire-rated walls, floors, and ceilings shall be properly fire stopped. Barriers between power and telecommunications cables shall be installed per electrical code. Cable trays and wire ways shall not be used as walkways or ladders unless specifically designed and installed for that purpose.
- C. Supports should be located where practicable so that connections between sections of the tray fall between the support point and the quarter section of the span. The support centers shall be in accordance with the load and span for the applicable class as specified in the electrical code. A support should be placed within 600 mm (2 ft.) on each side of any connection to a fitting. Wire ways shall be supported on 1500 mm (5 ft.) centers unless designed for greater lengths.
- D. Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.
 - 1. Cable tray shall be installed plumb, level, and square with finished building surfaces.
 - 2. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed according to the manufacturer's requirements.
 - 3. Cable tray elevation changes shall be gradual.

E. Cable Tray Routing:

1. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
2. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous, or corrosive areas.

F. Cable Tray Clearance Requirements:

1. Clearance requirements for cable tray accessibility:
 - a. Maintain a clearance of 6" between top of cable tray and ceiling structure or other equipment or raceway.
 - b. Maintain a clearance of 8" between at least one side of cable tray and nearby objects.
 - c. Maintain a clearance of 6" between bottom of cable tray and ceiling grid or other equipment or raceway.
2. Clearance requirements from sources of electromagnetic interference (EMI):
 - a. Maintain a clearance of 6" or more from fluorescent lighting.
 - b. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
 - c. Maintain a clearance of 48" or more from motors or transformers.
 - d. Pathways shall cross perpendicularly to electrical power cables or conduits.
3. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot- water pipes or other heat sources operating at temperatures above 100 degrees Fahrenheit.

G. Cable Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer's instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.

H. Cable tray supports shall be provided according to the manufacturer's recommendations.

1. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
2. Where cable trays abut walls, provide wall-mounted supports.
3. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
4. Trays shall be supported at 5-foot intervals minimum, or more frequently if required by the manufacturer.

I. Load Span Criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.

J. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.

K. Wire-type cable tray shall be cut with a manufacturer-approved cutter with "offset cutting blade" jaws and a minimum 24-inch handle.

1. The choice and position of the jaws at the point where the cut is made shall allow shearing as close as possible to the intersection of the steel wires.
 2. Cuts shall ensure the integrity of the galvanic protective layer.
- L. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are explicitly approved for bonding.
- M. Thermal Contraction and Expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and during normal occupancy and operation.
- N. Barrier Strips: Provide barrier strips as recommended by manufacturer.
- O. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.
- P. Slots/Sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide hammer drilling, core drilling, and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.

3.3 GROUNDING AND BONDING

- A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA standards and the references listed in Article 1.5 REFERENCES above, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Bond metallic raceway (including cable tray) together and to the nearest SBB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
- C. Cable Tray Bonding Splices: Provide cable tray splices according to manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.
- D. Bonding Conductors:
1. Bond distribution conduits to cable tray.
 2. Provide bonding jumpers at expansion joints, sleeves, and any other locations where electrical continuity is interrupted.
 3. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

3.4 FIRESTOPPING

- A. Only employees trained/certified by the fire-stopping manufacturer shall apply fire-stopping materials.
- B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made

during construction.

1. Provide fire stopping material for through and membrane penetrations of fire-rated barriers.
2. Install firestops in strict accordance with manufacturer's detailed installation procedures.
3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards referenced in Article 1.5 REFERENCES. Apply sealing material in a manner acceptable to the local fire and building authorities.
4. For demolition work, apply fire stopping to open penetrations in fire rated barriers where cable is removed. Apply fire stopping regardless of whether the penetrations are used for new cable or left empty after construction is complete.
5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/ re-enterable.

3.5 CLEANING AND PROTECTION

- A. After completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

3.7 LABELING AND ADMINISTRATION

- A. Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray:
 1. Label #1: Label shall read "TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY".
 2. Label #2: Label shall read "WARNING! CABLE TRAY SERVES AS A TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!"

END OF SECTION 27 05 36

SECTION 27 11 00 - COMMUNICATION EQUIPMENT ROOM FITTINGS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation

1.2 SUMMARY

- A. Make available all services, labor, materials, tools, and equipment essential for the complete and proper installation within the Telecommunications Rooms (TRs) and the Equipment Rooms (ERs) as specified in the Contract Documents.
- B. This section includes the minimum requirements and installation methods for the following:
 - 1. Equipment Racks and Cable Routing Hardware.
 - 2. Copper Terminations Equipment.
 - 3. Fiber Optic Terminations Equipment.
 - 4. Grounding and Bonding.
- C. Completely coordinate with work of other trades.

1.3 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Division 27 Sections include:
 - 1. 27 05 26 Grounding and Bonding for Communications Systems
 - 2. 27 05 28 Pathways for Communications Systems
 - 3. 27 05 29 Hangers and Supports for Communications Systems

1.4 QUALITY ASSURANCE

- A. All installation work in the TRs and ERs shall be performed in a professional and workmanlike manner. All methods of construction that are not explicitly described shall be subject to the control of Owner.
- B. All equipment and materials shall be of the quality and manufacturer indicated in the Contract Documents. The equipment specified is based on the acceptable manufacturer listed.
- C. Materials and work specified herein shall comply with the relevant requirements of:

1. NFPA 70 – National Electrical Code (NEC) Articles 250, 300 and 645.
2. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard
3. TIA-569-D Telecommunications Spaces and Pathways
4. TIA-606-C Administration Standard for Telecommunications Infrastructure
5. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
6. BICSI Telecommunications Distribution Methods Manual 13TH Edition

1.5 ARCHITECTURAL REQUIREMENTS

- A. New Telecommunications Rooms (TRs) and Equipment Rooms (ERs) shall be designed in compliance with the space, electrical, and environmental requirements of TIA-569-D Telecommunications Spaces and Pathways. Smaller spaces or enclosures shall not be acceptable without prior written approval from Owner.
- B. The locations for all TRs and ERs shall be designed to be within a 150' radius of all areas to be served with the understanding to maintain TIA distance standards for telecommunications cabling.
- C. Corridor access with the door to swing out is required for all new TRs and ERs, which shall comply with common area access requirements. No other rooms shall lead directly to or from the TR or ER.
- D. All walls of the TRs and ERs will be covered with rigidly fixed $\frac{3}{4}$ " A - C grade fire - resistant or non-combustible plywood backboard, void free, 8' high, painted with two coats of light-colored fire-retardant paint. Leave the Fire Rating seal exposed.
- E. TRs and Telecom ERs shall be open to the structure above (no suspended ceiling).
- F. The floor, walls and ceiling of the TRs and ERs shall be sealed to reduce dust. The floor shall be sealed concrete.
- G. The TRs and ERs shall not be shared for other purposes including, but not limited to, custodial, access services, electrical, mechanical, storage, etc.
- H. Equipment not related to the support of the TR or ER (e.g., piping, ductwork, pneumatic piping, electrical equipment, plumbing, etc.) should not be installed in, pass through, or enter the room.
- I. No equipment, hardware, piping, etc. shall be added in or near any TR or ER that will change the temperature or humidity of these rooms without written agreement from Owner prior to design and installation.
- J. New TRs and ERs shall not be adjacent to any electrical room or room containing a transformer or motors. Electrical power systems in or adjacent to the TRs and ERs should be configured such that their electromagnetic fields do not interfere with telecom cabling or equipment.
- K. As-built files shall be a part of the final punch list and not complete until Owner receives the final as-built files.

1.6 COMMUNICATIONS REQUIREMENTS

- A. Owner supplied prints shall be used for design on all projects with updates for each project.
- B. Communication as-built files shall be a part of the final punch list and not complete until Owner receives the final as -built files.

PART 2 PRODUCTS

2.1 BACKBOARDS

- A. All walls of the TRs and ERs will be covered with rigidly fixed 3/4" by 48" by 96" A/C grade fire - resistant or non-combustible plywood backboard, void free, 8' high, painted with two coats of light-colored fire-retardant paint if required. Field coordinate color with architect. Leave the Fire Rating seal exposed.
- B. Install D -rings on plywood backboard for cable routing in the TRs and ERs as required for the project and as shown on drawings.
- C. All new cables shall be supported using ladder cable runway, D- rings, and cable management hardware and shall be neatly dressed -out in the TRs and ERs.
- D. Clamp all new cables at the entrance to the TRs and ERs for strain relief.
- E. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.2 TELECOMMUNICATIONS EQUIPMENT RACKS

- A. Install new equipment racks with vertical and horizontal cable management in the TRs and ERs as required for project and as shown on drawings. All equipment racks shall be securely anchored to the concrete floor using minimum 3/8" hardware or as specified by rack manufacturer.
- B. The hardware layout in the racks shall follow the Owner standard format as shown in the typical rack layout drawings.
- C. Equipment placement shall be coordinated with Owner staff.
- D. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products (CPI).
 - 2. Hubbell.
 - 3. Panduit.
 - 4. Approved equivalent.
- E. Floor-Mounted Racks: 2-Post, Modular-type, steel or aluminum construction.
 - 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.

2. Baked-polyester powder coat finish.
3. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.

F. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.

2.3 POWER DISTRIBUTION UNITS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. Zero RU vertical or One RU horizontal per drawings, Single Phase, 120V Outlets, L5-30P Input Plug.
4. LED indicator lights for power and protection status.

2.4 GROUNDING AND BONDING

A. #6 AWG suitable for grounding cable pathways and equipment rooms.

1. All connectors and clamps shall be mechanical type made of silicon bronze.
2. Terminals shall be solderless compression type, copper long-barrel NEMA two bolt.
3. Telecommunications Bonding Backbone (TBB): Minimum 3/0 AWG insulated copper conductor.
4. Telecommunications Primary Bonding Busbar (PBB): Minimum 6 mm thick x 100 mm wide predrilled copper busbar with standard NEMA bolt hole sizing and spacing.
5. Telecommunications Secondary Bonding Busbar (SBB): Minimum 6 mm thick x 50 mm wide predrilled copper busbar with standard NEMA bolt hole sizing and spacing.
6. All grounding equipment shall be UL listed for that purpose.

PART 3 EXECUTION

3.1 RACKS AND CABLE ROUTING HARDWARE

- A. The Telecommunications Rooms (TRs) and Equipment Rooms (ERs) shall be equipped with hardware, such as plywood backboards, grounding bus bars, equipment racks, ladder cable runway, horizontal and vertical cable management, and copper and fiber termination equipment.
- B. Examine TRs and ERs and verify conditions are as shown on project drawings. Provide notification in writing of conditions deviating from drawings or detrimental to proper completion of the work.
- C. Beginning of installation in the TRs and ERs indicates Contractor acceptance existing conditions.

- D. Install new equipment racks with vertical and horizontal cable management in the TRs and ERs as required for project and as shown on drawings. All equipment racks shall be securely anchored to the concrete floor using minimum 3/8" hardware or as specified by rack manufacturer.
- E. Install new ladder cable runway for cable routing in the TRs and ERs as required for project and as shown on drawings. All ladder cable runway shall be securely anchored to the walls with support kits and brackets as specified by manufacturer. Secure equipment racks to ladder cable runway with all-thread covered with EMT conduit sleeve.
- F. Install 3/4" fire-rated AC grade plywood backboard on the walls in the TRs and ERs as required for the project and as shown on drawings. All plywood backboard shall be securely anchored to the walls.
- G. Install D-rings on plywood backboard for cable routing in the TRs and ERs as required for the project and as shown on drawings.
- H. All new cables shall be supported using ladder cable runway, D- rings, and cable management hardware and shall be neatly dressed -out in the TRs and ERs.
- I. Clamp all new cables at the entrance to the TRs and ERs for strain relief.
- J. Firestop all sleeves and conduit openings after the cable installation is complete.
- K. The hardware layout in the racks shall follow the Owner standard format as shown in the typical rack layout drawings.
- L. Equipment placement shall be coordinated with Owner staff.

END OF SECTION 27 11 00

SECTION 27 11 16 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. The work covered in this section consists of the furnishing and installation of all necessary labor, supervision, materials, equipment, tests, and services to install communications cabinets, racks, frames, and enclosures.
- B. Related Sections:
 - 1. 27 05 26 Grounding and Bonding for Communications Systems
 - 2. 27 05 28 Pathways for Communications Systems
 - 3. 27 05 29 Hangers and Supports for Communications Systems
 - 4. 27 05 36 Cable Trays for Communications Systems
- C. Standards and Codes References:
 - 1. EIA:310D
 - 2. TIA 568.1-D Set and all addenda: Commercial Building Telecommunications Infrastructure Standard.
 - 3. TIA 569-D and all addenda: Telecommunication Spaces and Pathways.
 - 4. TIA 606-C and all addenda: Administration Standard for Telecommunications Infrastructure.
 - 5. TIA 607-C: Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.

1.3 SUBMITTALS

- A. Provide detail elevation drawings of each equipment cabinet in the TRs and ERs.
- B. Provide manufacturer's literature and sample of telecommunications installation materials.
- C. Comply with the National Electrical Code (NFPA 70, "National Electrical Code").
- D. Comply with TIA and BICSI installation manuals.

1.4 COORDINATION

- A. Coordinate layout and installation of equipment cabinets with communications cabling installation, data switches, termination fields and patch panels, and all other equipment to mount inside the equipment cabinet.
- B. Adjust arrangements and locations of equipment in ERs and TRs to accommodate and optimize arrangement and space requirements as approved by the EPA.
- C. Coordinate with other sections as required ensuring that the entire work will be carried out in orderly, complete, and organized fashion.

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment cabinets shall be standard 84" (44-45 RU) Width (19" W) EIA-310-D compliant. Furnish and installed as shown in the drawings. Equipment cabinets shall be grounded per TIA standards and equipped with the following:
 - 1. Contain rails conforming to EIA RS-310-D standards for mounting equipment.
 - 2. Acceptable Manufacturers:
 - a. CPI
 - b. Hubbell
 - c. CommScope
 - d. Or approved equal
 - 3. Vertical wire management extending the full height of the cabinet including both sides; front and back.
 - 4. Horizontal wire management as shown on the contract drawings.
 - 5. Equipment cabinets shall be placed to be accessible from both front and back.
 - 6. 30A single phase 120V Metered Power Distribution Units:
 - a. Two-digit lighted meter reports combined total output current in amps.
 - b. Zero RU vertical rackmount.
 - c. 30A circuit breaker and lighted power switch in transparent protective cover.
 - 7. Acceptable Manufacturers:
 - a. APC
 - b. TrippLite
 - c. Or approved equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. Verify installation methods specified by the manufacturer prior to installation.

- B. Ensure the equipment cabinets will fit the footprint allocated prior to attempting installation.
- C. Plan for the space needed for installation of both equipment and cable.
- D. Plan for the equipment to be installed in the equipment cabinet. Ensure that the open space recommendations are adhered to for airflow between electronic equipment. Also ensure that is adequate space for cable so that bend radius and separation requirements are met.

3.2 GROUNDING

- A. Attach a bonding conductor sized as defined in TIA-607-C and as defined by local code or the authority having jurisdiction (AHJ) between the Bonding Busbar and the equipment cabinets. The installer shall provide the bonding conductor and other necessary hardware required to make the connections between the equipment cabinets and the Bonding Busbar.

END OF SECTION 27 11 16

SECTION 27 13 13- COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 GENERAL

1.1 SUMMARY

- A. This section provides the requirements for the installation of multi-pair unshielded twisted pair (UTP) cables and associated hardware for copper backbone cabling. Included in this section are the product requirements for cable, termination hardware, and other required hardware. Installation practices and test requirements are also indicated in this section.
- B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard, ANSI/NECA/BICSI 568.2006 Standard for Installing Telecommunications Systems, and all relevant BICSI manuals including 13th Edition Telecommunications Distribution Methods Manual. Contractor must submit Drawings and receive approval from Owner's Project Manager for any deviations from standards or drawings due to field conditions.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. NFPA 70 National Electric Code.
- B. Authority Having Jurisdiction (AHJ).
- C. Local Building Codes.
- D. UL® Standard 910 "Test method for fire and smoke characteristics of cable used in air handling spaces." Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program. UL® Standard 1666 "Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts."
- E. American National Standards Institute/Telecommunications Industry Association ANSI/TIA, including associated Addenda:
 - 1. TIA-568.1-D Commercial Building Telecommunications Infrastructure
 - 2. TIA-569-D Telecommunications Spaces and Pathways
 - 3. TIA-606-C Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 - 4. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- F. National Electrical Manufacturers Association (NEMA).
- G. ANSI/NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunication Cabling.

- H. American Society for Testing Materials (ASTM).
- I. Institute of Electrical and Electronic Engineers (IEEE).

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents including Divisions 0, 1, 15, 26, 27, 28, and the general contract specifications as applicable.
- B. Related specification sections:
 - 1. Section 27 05 28 Pathways for Communications Systems
 - 2. Section 27 05 29 Hangers and Supports for Communications Systems
 - 3. Section 27 05 36 Cable Trays for Communications Systems
 - 4. Section 27 11 16 Communications Racks, Frames and Enclosures
 - 5. Section 27 11 00 Communications Equipment Room Fittings

1.4 SUBMITTALS

- A. Product Data:
 - 1. The contractor shall submit product data sheets and samples for all products specified under this section.
 - 2. Products requiring submittals shall include but are not limited to the following:
 - a. All cabling and wire.
 - b. Patch Cables.
 - c. All connectors and required tools.
 - d. All termination system components for each cable type.
 - e. All equipment room and telecommunications room horizontal cable management.
 - f. All grounding system components.
 - g. All firestop systems (including manufacturer published installation requirements).
 - h. All cable raceway and support hardware.
 - i. Other apparatus required for a complete and functional system.
 - 3. Products requiring samples shall include but are not limited to the following:
 - a. All cabling and wire.
 - b. Patch Cables.
 - c. All connectors and required tools.
 - d. All termination system components for each cable type.
 - e. All equipment room and telecommunications room horizontal cable management.
 - f. All grounding system components.
 - g. All firestop systems (including manufacturer published installation requirements).
 - h. All cable raceway and support hardware.
- B. Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the

- cabling and asset identification system of the software.
- 3. Cabling administration drawings and printouts.
- 4. COMM /LAN room Equipment rack layout and elevations.
- 5. Wiring diagrams to show typical wiring schematics including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - d. Cross-connects and patch panels. Detail mounting assemblies and show elevations and physical relationship between the installed components.
- C. Project Closeout Test Data:
 - 1. The contractor shall provide test documentation.
- D. As-Built Documentation:
 - 1. The contractor shall submit as-built documentation.
- E. Warranty:
 - 1. The contractor shall provide a warranty.

PART 2 PRODUCTS

2.1 CABLE

- A. 25-Pair Category 5E:
 - 1. 25-pair count cable shall be comprised of 24 AWG twisted pair copper conductors and sheathed in a PLENUM rated thermoplastic outer jacket. Pairs shall be color coded in accordance with ANSI/ICEA S-80-576.
 - 2. Cable jacket material shall conform to Article 800 NEC for use as plenum or non- plenum cables. Cables shall be UL® type CMP (PLENUM) and/or UL® listed for fire safety.
 - 3. Cable shall meet or exceed ANSI/TIA/EIA-568-B.2 for Category 5E compliance

2.2 PATCH PANELS

- A. Patch panel shall be high density such that 24-ports occupy one rack unit and 48 ports occupy two rack units.
- B. Patch panel shall use Category 5 E, RJ45 jacks in 6 or 8- port modules.
- C. Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110D-type insulation displacement contact, printed circuit board, to lead frame-mounted connector.
- D. Patch panel jack shall be universal modular jack, 8 position, un-keyed unless noted otherwise.
- E. Patch panel jack shall support termination of 22, 24, and 26 AWG solid conductor, four-pair, and

unshielded twisted pair copper cable.

- F. Patch panel shall have rear-mounted cable management bar to ensure proper bend radius and strain relief for cabling.
- G. Patch panel shall have the ability to accept color-coded identification tabs and port protecting shutters.
- H. Patch panel shall be compliant with TIA-606-C labeling specifications.

2.3 SUPPORTING HARDWARE

- A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.
- B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

PART 3 EXECUTION

3.1 GENERAL

- A. The backbone cabling systems shall provide interconnections between telecommunications rooms, equipment rooms and entrance facilities. The system includes backbone cables, intermediate, and main cross-connects, mechanical terminations used for backbone cross-connects.
- B. Specified pulling tensions and bend radius shall be used in the installation of cables.
- C. The proximity of backbone cabling to potential sources of RFI and EMI shall be considered when installing cable.
 - 1. Maintain at least 6 inches of clearance away from fluorescent lighting fixtures and electrical conductors up to two kVA.
 - 2. Maintain at least 24 inches of clearance away from electrical conductors up to five kVA.
 - 3. Maintain at least 36 inches of clearance away from electrical conductors more than five kVA.
 - 4. When cabling is required to cross over electrical conductors, they must do so at a 90-degree angle.
 - 5. Electrical cabling is not permitted to lie on top of communication cabling.
- D. The contractor shall bond both ends of all cable shields to the appropriate PBB/SBB.
- E. All cabling shall be labeled per specifications; no handwritten labels will be acceptable.
- F. All backbone cabling shall be run with no splices.
- G. Contractor shall adhere to TIA/EIA 568/569 specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.

3.2 INSIDE PLANT CABLE

- A. The backbone cabling shall be configured in a logical star topology.
- B. The backbone shall be limited to no more than two hierarchical levels of cross-connects. No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two-horizontal cross-connects.
- C. The distance between the terminations in the entrance facility and the main cross-connect shall be documented by the Contractor and shall be made available to the access provider.
- D. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.

3.3 PATCH CABLES

- A. Provide one CAT 5E patch cord per port. Coordinate colors and lengths with building IT staff.
- B. Patch color codes are determined by their application. Patch cord color and quantity shall be coordinated with Owner Project Manager.
- C. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

3.4 TESTING

- A. Inside Plant Cable:
 - 1. Testing of all copper wiring shall be performed prior to system cutover. 100 percent of the horizontal, riser and inter-cabinet wiring pairs shall be tested for opens, shorts, polarity reversals, transposition and presence of AC voltage.
 - 2. Multi-pair cables shall be tested to each Telecom Room. The cable runs shall be tested for conformance to the specifications of TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard and TIA-568-C.2 Balanced Twisted Pair Cabling and Components Standards.
 - 3. Testing shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end and far end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor or replaced at no cost to Owner.
 - 4. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.
 - 5. Contractor shall submit current calibration certificate(s) for each piece of test equipment to be utilized. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
 - 6. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to Owner in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically, the Contractor shall provide one copy of software and appropriate license with the test data.
 - 7. Each test shall be given a test identification number. For high pair count UTP backbone cables, the cable identification shall be used as the test identification. High-count UTP

- backbone cables shall be divided into 1-pair increments and each shall have a unique test identifier.
8. Test data shall be organized and grouped by individual Telecommunications Room (TR) with the summary report followed by a detailed test sheet for each cable tested. All results shall be sorted by test identification numbers and bound in 3-ring binders (no larger than three (3) inches thick each).
 - a. Project closeout test report shall include the following: Installation company name, contact information, project manager and installation supervisor name.
 - b. Project scope including project start and end dates, building name and address, and floors where installation work was completed.
 - c. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
 - d. 4-pair cable testing data including, at a minimum, test identification, cable length, pass/fail, test parameter title, test data, and test time.
 - e. Installation Contractor Warranty.
 - f. Structured Cabling Manufactures Warranty.
 - g. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
 - h. Elevation and plan view drawings for cabinet and rack elevations.
 9. Acceptable copper test sets:
 - a. Fluke.
 - b. Engineer approved equal.

END OF SECTION 27 13 13

SECTION 27 13 23- COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 GENERAL

1.1 SUMMARY

- A. This section provides the requirements for the installation of a fiber optic backbone system. Included in this section are the product requirements for the fiber optic cables, termination hardware, and required support apparatus. In addition, installation and testing requirements for fiber optic systems is included in this section.
- B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, TIA-568.0-D Generic Telecommunications Cabling for Customer Premises, TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard, TIA-568.3-D Optical Fiber Cabling and Components Standard, TIA-598-D Optical Fiber Cable Color Coding, ANSI/NECA/BICSI 568.2006 Standard for Installing Commercial Building Telecommunications Cabling and all relevant BICSI manuals including 13th Edition Telecommunications Distribution Methods Manual. Contractor must submit shop drawings and receive approval from Owner for any deviations from standards or drawings due to field conditions.
- C. Completely coordinate with work of other trades.

1.2 REFERENCES

- A. NFPA 70 National Electric Code.
- B. Authority having jurisdiction (AHJ).
- C. Local Building Codes.
- D. UL® for wiring: UL® Standard 910 "Test method for fire and smoke characteristics of cable used in air handling spaces." Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program. UL® Standard 1666 "Test for Flame Propagation Height of Electrical and Optical- Fiber Cables Installed Vertically in Shafts."
- E. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance ANSI/TIA/EIA, including associated Addenda:
 - 1. TIA-526-14-C Measurement of Optical Power Loss Installed Multimode Fiber Cable Plant
 - 2. TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
 - 3. TIA-568.1-D Commercial Building Telecommunications Infrastructure Standard
 - 4. TIA-569-D Telecommunications Spaces and Pathways
 - 5. TIA-606-C Administration Standard for Telecommunications Infrastructure
 - 6. TIA-607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
 - 7. TIA-758-B Customer-Owned Outside Plant Telecommunications Infrastructure Standard
 - 8. TIA-526-7-A Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable

- Plant
- 9. TIA-598-D Optical Fiber Cable Color Coding.

- F. National Electrical Manufacturers Association (NEMA).
- G. ANSI/NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling.
- H. American Society for Testing Materials (ASTM).
- I. Institute of Electrical and Electronic Engineers (IEEE).

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents including Divisions 0, 1, 15, 26, 27, 28, and the general contract specifications as applicable.
- B. Related specification sections
 - 1. Section 27 05 28 Pathways for Communications Systems
 - 2. Section 27 05 29 Hangers and Supports for Communications Systems
 - 3. Section 27 05 36 Cable Trays for Communications Systems
 - 4. Section 27 11 16 Communications Racks, Frames and Enclosures

1.4 SUBMITTALS

- A. Product Data:
 - 1. The contractor shall submit product data sheets and samples for all products specified under this section.
 - 2. Products requiring submittals shall include but are not limited to the following:
 - a. All cabling and wire.
 - b. Patch cables.
 - c. All connectors and required tools.
 - d. All termination system components for each cable type.
 - e. All equipment room and telecommunications room horizontal cable management.
 - f. All grounding system components.
 - g. All firestop systems (including manufacturer published installation requirements).
 - h. All cable raceway and support hardware.
 - i. Other apparatus required for a complete and functional system.
 - 3. Products requiring samples shall include but are not limited to the following:
 - a. All cabling and wire.
 - b. Patch cables.
 - c. All connectors and required tools.
 - d. All termination system components for each cable type.
 - e. All equipment room and All cable raceway and support hardware.
 - f. telecommunications room horizontal cable management.

- g. All grounding system components.
 - h. All firestop systems (including manufacturer published installation requirements).
- B. Drawings: The contractor shall submit shop drawings and cable riser diagrams.
- C. Project Closeout Test Data: The contractor shall provide test documentation
- D. As-Built Documentation: The contractor shall submit as-built documentation.
- E. Warranty: The contractor shall provide a warranty.

PART 2 PRODUCTS

2.1 CABLE

- A. 50µm Laser Optimized Multimode Fiber Optic Cable (OM4)- 24 strands.

1. 50µm multimode fiber optical cables shall have the following features:

- a. All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic multimode step index cables with the following operational and construction features
 - 1) All-Dielectric Self-Supporting.
 - 2) Color-coded PVC buffers for easy installation.
 - 3) Used for both vertical and horizontal applications in buildings.
 - 4) Supports 10 Gbps Ethernet applications to 300 meters or 1 Gbps to 1,000 meters.
 - 5) Legacy support: Ethernet, Fast Ethernet, Token Ring, ATM, FDD.
 - 6) Compliant with IEC 60793 and EIA/TIA 492 specifications.
- b. Where armored cable is called for, cable shall be protected by flexible metal armor.
- c. Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound.

2. Multimode fiber optic cables shall meet the following physical specifications:

Core Diameter:	50µm+/-3µm
Core/Cladding Concentricity Error:	<=1.5µm
Cladding Non-Circularity:	<2.0%
Coating Diameter (uncolored):	245+/-10µm
Proof Test Levels:	0.76 pa minimum
Operating Temperature Range:	-40 degrees C to 70 degrees C
Core Non-Circularity:	<=5%
Cladding Diameter:	125µm+/-2µm
Colored Fiber Diameter:	250+/-15µm

Coating/Cladding Concentricity Error:	+/-8µm
Minimum Tensile Strength:	100,000psi

3. Multimode fiber optic cables shall meet or exceed the following optical specifications:

Maximum Attenuation:	2.4dB/kmat850nm0.7dB/kmat1300nm
Minimum Bandwidth:	3500MHz-kmat850nm (overfilled)500MHz-km at 1310nm (overfilled)4700MHz-km at 850nm (laser)500MHz-km at 1300nm (laser)
Numerical Aperture:	0.200+0.015
Nominal Refraction Index Difference by Peak of Core and Cladding:	1.00%
Effective Group Index of Refraction @850nm:	1.483
Effective Group Index of Refraction @1300nm:	1.479
Point Discontinuities @850nm and 1300nm:	<=0.2dB

4. Acceptable manufacturers and products:

- a. AFL
- b. Corning Cabling Systems
- c. Hubbell
- d. Superior Essex
- e. Or approved equal

2.2 CONNECTORS

A. Multimode:

1. LC:

- a. All multimode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Multimode LC connectors must have the following features:
 - 1) Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
 - 2) LC connectors shall meet ANSI/TIA/EIA 568-C.3 standard.
- b. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- c. Acceptable manufacturers and products: Corning Cabling Systems or approved

equal.

2. SC:

- a. Where required for use, SC connectors are to have the following features:
 - 1) Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
- b. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- c. Acceptable manufacturers and products: Corning Cabling Systems or approved equal.

3. Connector Parameters

- a. Multimode connectors, LC and SC shall meet the following specifications:

Parameters	Multimode
Interconnection Compatibility	LC or SC Connectors
Insertion Loss	Composite Ferrule: 0.5 dB typical Standard Ceramic Ferrule: 0.3 dB Typical
Durability	1000 re-matings <0.20 dB change
Tensile Strength	20 lb., ≤ 0.20 dB change
Temperature Cycling	-40°C to +80°C, 40 cycles, <0.30 dB change
Material	Ferrule: Pre-radiused Zirconia Housing: Thermoplastic

2.3 TERMINATION HARDWARE

- A. Contractor shall provide and install fiber optic patch panels as indicated on drawings.

- B. 24 Port Fiber Optic Termination Shelves.

- 1. 24 port fiber optic Fiber Termination Shelves are to have the following features:

- a. 24 port.
- b. 2 RU height Maximum.
- c. 19" Rack Mountable.
- d. Front loading panels.
- e. Fully loaded bulkheads as required.
- f. Comply with TIA-606-C Labeling.
- g. Front cable management rings for patch cord slack.
- h. Acceptable manufacturers and products:
 - 1) Corning Cabling Systems
 - 2) Hubbell

3) Or approved equal

2.4 FIBER OPTIC PATCH CABLES

A. Multimode

1. Provide 50-Micron OM4 dual or duplex (with identifying markings), LC-Type fiber optic patch cords with 3-meter length.
2. Fully compatible with OM4 50 Micron Fiber Optic Risers and Patch Panels.
3. Color: Aqua.
4. The contractor shall provide one patch cord for each fiber port installed to the Owner or project manager at such time as required for Owner installation of network and/or workstation equipment. Coordinate lengths with network administrator.
5. All patch cords are to be factory fabricated.
6. All patch cords are to be the recommended series intended by the manufacturer to integrate with the installed cable segments and termination hardware. All patch cords are to be manufactured by the same vendors as the optical fiber cable and hardware.
7. Contractor shall provide patch cords in the quantities indicated in the drawings. Contractor shall provide a schedule of all cords indicating the planned lengths, quantities, and colors to Owner for approval prior to placing any orders for cords.

2.5 SUPPORTING HARDWARE

- A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.
- B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

PART 3 EXECUTION

3.1 GENERAL

- A. Optical fiber cabling shall be provided between facilities and furnished with the quantity of fibers as designed on the contract drawings. All fiber cable runs shall be from the same manufacturer and shall be of the same type.
- B. Design shall allow for migration of the pull-through, interconnect, or splice implementation to a cross-connection implementation. Sufficient space shall be left in the telecommunications room to allow for the addition of patch panels needed for the migration of the pull-through, interconnect, or splice to a cross-connection. Sufficient cable slack shall exist in the telecommunications room to allow movement of the cables when migrating to a cross-connection.
- C. Fiber cable shall have enough cable slack at the termination point to allow for routing cable through the termination hardware and back to a work table for fiber terminations, plus an additional 3 meters.
- D. Slack may be stored as either cable or unjacketed fiber. Slack storage shall provide bend radius

control so that the cable and fiber bend radius limitations are not violated. Fiber slack shall be stored in a protective enclosure and slack cable may be stored on walls, cable trays or enclosures within the telecommunications.

- E. All cabling shall be labeled per specifications.
- F. All non-armored fiber optic cable shall be run in conduit/innerduct. Multiple fiber cables may be run in a single conduit/innerduct.
- G. Contractor shall adhere to TIA 568/569 specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.
- H. The use of field terminated connectors shall be limited to backbone cabling, campus cabling, or vendor specific requirements.
 - 1. All fiber optic cabling shall be terminated with either LC connectors unless a vendor specific requirement requires a different type of connector for a specific and limited application. Coordinate final connector type determination with the owner representative. The following installation practices shall be followed:
 - a. Fiber optic cable sheaths are not permitted to be deformed. Use only approved cable fasteners such as hook and loop.
 - b. Do not pull fiber optic cabling with copper cabling.
 - c. Do not exceed the fiber optic cable maximum pulling tension.
 - d. In multiple fiber optic pulls, pull fiber optic cables of the same weight and design.
 - e. Do not exceed the maximum pulling tension of the lowest rated fiber optic cable.
 - f. Do not pull fiber optic cable over existing cables. Friction could be excessive and cause damage.
 - g. Do not exceed maximum bend radius, both pulling and installed radius.
 - h. Do not pull fiber optic cable around sharp corners such as support brackets, rods, etc.
 - i. Protect fiber optic connectors when using pre-connectorized cables. Use approved pulling grips.
 - j. The use of lubricants is recommended for all fiber optic cable pulls. Lubricants should be approved for use with the fiber optic cable type. Never use detergent based lubricants when installing loose tube fiber optic cable.
- I. Non-armored fiber optic cables installed within conduit shall be protected by using innerduct. If fiber optic cable is to be installed in conduit without any innerducts, the installer shall install innerducts to sectionalize the conduit. Each innerduct shall have pull tapes/line in each empty innerduct.
- J. Fiber optic cables are not permitted to provide support for other cables or hardware. Never secure other cables or hardware to fiber optic cabling.
- K. Cable that is individually supported may be taped or tied together every 3 meters for cable management but not for support.
- L. When routing fiber optic cabling along walls to the termination or splice enclosure, protect fiber optic cabling by installing in innerduct. Place fiber optic warning signs along innerduct. Ensure there is enough cable slack to be able to move the fiber optic termination hardware to any potential installation area in the room.

- M. Fiber optic cabling termination shall follow the TIA 598 color code chart. To retain the correct polarity through the cabling system, the correct fiber polarity must be followed. Fiber cabling must be installed to pair an odd-numbered fiber with the next sequential even-numbered fiber. Each fiber pair shall be installed in a pair crossover orientation. Off-numbered fibers at position A at one end are at position B at the other end. Even-numbered fibers are at position B at one end and position A at the other end.

3.2 INSIDE PLANT FIBER

- A. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.
- B. Vertical fiber optic cable placement shall be installed by working from the top down when possible.
- C. Install a split wire mesh support grip at the top of each run. Fiber optic cable shall have its own split wire mesh support grip at the top of the run.

3.3 PATCH CABLES

- A. Patch color codes are determined by their fiber type. Match all patch cords to the installed fiber's OM rating.
- B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

3.4 TESTING

- A. The contractor shall test all optical fiber cable prior to the installation of the cable. The contractor shall assume all liability for the replacement of the cable should it be found defective at a later date.
- B. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.
- C. Loss Budget:
1. Loss budget: Contractor shall provide calculations indicating the maximum loss budget for each fiber using the following formula.
 2. $(\text{Allowable cable loss per KM}) * (\text{KM of Fiber in Link}) + (\text{MFR Published Connector Loss}) * (\text{Number of Connectors}) \text{ loss} = \text{Maximum Allowable Loss.}$
 3. The contractor shall provide loss budgets to Owner for review prior to testing.
 4. The contractor shall notify Owner in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
 5. The contractor shall submit calibration certificate(s) indicating that the test set(s) has been calibrated by the manufacturer. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
 6. End-to-end loss shall be less than the loss budget. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no cost to the Owner.

D. Test Data:

1. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to Owner in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically contractor shall provide one copy of software and appropriate license with the test data.
2. Test data shall reflect the Owner labeling scheme.
3. A sample Test Instrument Data Sheet is attached.
4. A sample Reference Power Measurement Form is attached.

E. Project closeout report shall include the following:

1. Installation company name, contact information, project manager, and installation supervisor name.
2. Project scope including project start and end dates, building name and address, and floors where installation work was completed.
3. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops, and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
4. Fiber optic loss test data and OTDR test data including, at a minimum, test identification, pass/fail, test parameter title, test data and test time.
5. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
6. Elevation and plan view drawings for cabinet and rack elevations.

F. Multimode:

1. Testing shall be performed on all fibers in the completed end to end system. Testing shall consist of a bi-directional end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all multimode strands over 100 meters) and bi-directional end-to-end light source-power meter test (all multimode strands). All tests shall be performed in accordance with TIA/EIA-568C.3 and TIA/EIA-526-14A Method B: Intrabuilding or Riser. The system loss measurements shall be provided at 850 and 1300 nanometers for all fibers.
2. Acceptable multimode fiber optic test sets:
 - a. Noyes.
 - b. Corning Cable Systems.
 - c. Alcoa Fujikura.
 - d. Tektronix.
 - e. Engineer approved equal.
3. Acceptable tests for light source-power meter testing of multimode fiber optic cables:
 - a. Agilent Technologies.
 - b. Corning Cable Systems.
 - c. Fluke.
 - d. Engineer approved equal.

END OF SECTION 27 13 23

SECTION 27 15 13 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Pathways
2. Unshielded Twisted-Pair (UTP) Cable
3. Unshielded Twisted-Pair (UTP) Cable Termination Hardware
4. Consolidation Points
5. Telecommunications Outlet/Connectors
6. Multi-User Telecommunications Outlet Assembly (MUTOA)
7. Coaxial Cabling
8. Shielded Twisted-Pair Cable for AV Technology
9. Unshielded Twisted-Pair Cable for AV Technology
10. Automatic Infrastructure Management (AIM)
11. Grounding
12. Labeling

- B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.
- D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

- F. EMI: Electromagnetic interference.
- G. IDC: Insulation displacement connector.
- H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- I. LAN: Local area network.
- J. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications' outlet/connectors.
- K. NEC: National Electric Code.
- L. NTRL: Nationally Recognized Testing Laboratory.
- M. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- N. RCDD: Registered Communications Distribution Designer.
- O. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.
- P. SCS: Structured Cabling Systems.
- Q. TO: Telecom Outlet.
- R. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.
- S. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. Transmission performance requirements for balanced twisted-pair cabling are specified in TIA-568-C.2. This cable and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - 1. Category 6 unshielded twisted-pair cabling is used to provide connections to work areas for both voice and data.
 - 2. Category 6 shielded twisted-pair cabling can be used to provide connections for AV applications.
 - 3. Category 6A unshielded twisted-pair cabling can be used to provide connections for wireless access points and where specified, AV applications.
 - 4. TIA-568.1-D requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 5. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications out-let/connector.

6. Bridged taps and splices shall not be installed in the horizontal cabling.
7. Splitters shall not be installed as part of the optical fiber cabling.

- B. A work area is approximately 150 sq. ft. and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90m). This maximum allowable length does not include an allowance for the length of 16 feet (5m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (5 m) in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.2, when tested according to test procedures of this standard.

1.6 SUBMITTALS

- A. Product Data: Specification for each type of product is required.

1. For horizontal cabling, include the following installation data for each type used:

- a. Cable cut sheet.
- b. Patch panels.
- c. Patch cords.
- d. Devices and cover plate.
- e. Jacks.

- B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - d. Devices and cover plate.
5. Cross-connects and patch panels: Detail mounting assemblies and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

- d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Samples: For wall or workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration, and faceplates for color selection and evaluation of technical features.
- D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- E. Field quality-control reports.
- F. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of a RCDD.
- B. Installation Supervision: Work related to telecommunications shall be installed by Certified Installers and supervised by an SCS manufacturers authorized or certified SCS Engineer.
- C. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Telecommunications Spaces and Pathways shall comply with ANSI/TIA-569-C as well as all ANSI/TIA standards where applicable and all other related Codes.
- F. Grounding and bonding shall comply with ANSI/TIA-607-C and NEC where required.
- G. The Structured Cabling Systems Contractor Qualifications: Comply with Project general requirements and additional requirements specified in this section or other sections. Prior to bidding, obtain and maintain all licenses required for system installation work required by the local Authority Having Jurisdiction (AHJ). Additional installer/provider qualifications are indicated on telecommunications drawings and/or listed below:
 - 1. System installer must have on staff a Registered Communications Distribution Designer (RCDD®) certified by Building Industry Consulting Service International (BICSI).
 - 2. The Structured Cabling Systems Contractor selected must be an authorized installer in good standing capable of providing an Assurance Program which provides that the certified system will support the applications for which it was designed during the 25-year warranty of the certified system. The second portion of the certification is a 25-year warranty provided by the manufacturer and the vendor on all products within the system (cords, telecommunications out-let/connectors, cables, cross-connects, patch panels, etc.) The Structured Cabling Systems Contractor must provide a resume and qualifications for the Structured Cabling Systems Contractors' Project Manager and the on-site super-visors and technicians that will be assigned to the Project.
 - 3. The Structured Cabling Systems Contractor selected must provide a list of training and certifications for the Structured Cabling Systems Contractor personnel that will install any

materials for the Project. List will be subject to review and approval by the Owner's Representative.

4. The Structured Cabling Systems Contractor shall have at least 10 years' experience installing and servicing telecommunications systems of similar scope.
5. Product listing: Systems and equipment shall be listed and labeled by a nationally recognized testing laboratory (ETL, UL, and/or NRTL) for compliance with referenced standards. All items of telecommunications system shall be listed as a product of a telecommunications system manufacturer under appropriate category by NRTL and shall bear appropriate label.
6. Materials and equipment: Materials and equipment shall be latest cataloged products of manufacturers regularly engaged in production and installation of telecommunications systems. Materials and equipment shall be manufacturer's latest standard design and comply with specification requirements.

1.8 TESTING REQUIREMENTS

- A. During the installation process all cables must be tested for accuracy and performance, and results documented. Test results shall be automatically evaluated by equipment, using most up to date criteria from TIA-568-C.2 standards and all other applicable standards and results shown as Pass/Fail.
- B. Test reports shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The printed test results shall include all tests performed, expected test result and actual test received. The test report shall be available electronically, at no additional cost, for a minimum of five years.

C. Copper Cable

1. Cabling Testing Requirement

- a. All horizontal cables and termination hardware shall be 100% tested by the installation contractor for defects in installation and to verify cable performance under installed conditions.
- b. Testing should be done according to ANSI/TIA-568-C.2 for Category 6 and/or Category 6A, using an appropriate Level VI testing instrument, to verify both the integrity of all conductors and correctness of the termination sequence.
- c. All defects in cabling system installation shall be repaired or replaced to ensure 100% useable conductors in all cables installed at no additional expense to the Owner.
- d. See ANSI-TIA1152 for associated field test equipment requirements.

2. Documentation

- a. Documentation of cable testing shall be required, and the engineer shall be present during all tests.
- b. Test Reports for all factory testing and field test reports for all copper cabling shall be submitted to the owner's representative and manufacturer prior to commissioning voice and data systems and final payment.
- c. Certification Test Reports shall be submitted in electronic format using the appropriate software supplied by the test equipment manufacturer. The data format should be that of the test report software. The SCS Contractor shall provide any necessary software to view and evaluate the data. The SCS contractor shall provide

- a table of test results submitted with the as-built drawings.
- d. The report shall indicate all defective pairs and test results of all pairs listed above. Cables not complying with ANSI/TIA-568-C.2 shall be identified to the Project Manager for corrective action which shall include replacement at no additional expense to the Owner.

3. Field-Test Instrument Calibration

- a. The test instrument documentation shall include certification of calibration according to manufacturer's requirements. Additionally, the test instrument shall report the date and time of its current calibration.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials maintaining an orderly, clean appearance. If stored on site in open or unprotected areas, all equipment and material shall be kept off ground by means of pallets or racks and covered with tarpaulins.
- B. Store cable trays and accessories in original cartons and in clean dry space to protect from weather and construction traffic. Wet materials will be unpacked and dried before storage.
- C. Any material or workmanship found by the Owner or their Representative to be defective, inoperable, damaged, or the like, the Vendor will replace at their own expense. According to BICSI ITSIM, cables should be tested upon receipt.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. All work put into place prior to Substantial completion shall be the responsibility of the Vendor to protect all equipment, racks, panels, cabling, terminations, etc. from damage, dust, dirt and debris, by an approved means.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- C. All Project coordination, communication, change directives shall be coordinated by the A/E and passed through the General Contractor and and/or the Owner's representative.
- D. Coordinate cabling installation (especially cable tray location) with all other trades to avoid conflicts with other trades above the ceiling.

PART 2 PRODUCTS

2.1 PATHWAYS

- A. Pathways shall comply with ANSI/TIA-569-D Telecommunications Spaces and Pathways.
- B. Cable Support shall be labeled for support of Category 6A 4-pair UTP cables, designed to prevent degradation of cable performance and pinch points that could damage cable.
- C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
 - 1. Outlet boxes shall be no smaller than 4 11/16 inches square, and 2-1/4 inches deep.
 - 2. Refer to the electrical drawings for Tele/Data outlet locations including J-Boxes and conduit with pull string for all Tele/Data outlets.
 - 3. Flexible metal conduit shall not be used

2.2 UNSHIELDED TWISTED-PAIR (UTP) CABLE

- A. Description: Category 6, 100-ohm, 4-pair UTP cable, Blue.
 - 1. Comply with TIA/EIA-568-C.2 for performance specifications (Category 6).
 - a. CommScope
 - b. Superior Essex
 - c. Hubbell
 - d. Or Approved Equivalent
 - 2. Shall meet the following specifications:
 - a. Maximum Operating Frequency of 250MHz
 - b. Maximum diameter of 0.226 in
 - c. Maximum DC Resistance of 7.61 Ohms/100m
 - d. Mutual Capacitance of 5.6 nF/100m at 1 kHz
 - e. Nominal velocity of propagation (NVP) of 71%
 - f. Maximum operating voltage of 80V
 - g. Conductor gauge of 23 AWG
 - h. Type of Braid Tape
 - i. Maximum Pulling Tension of 11kg or 25 pounds
 - 3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications Plenum Rated: Type CMP
 - b. Communications Riser Rated: Type CMR
- B. Description: Category 6A, 100-ohm, 4-pair UTP cable, Blue.
 - 1. Comply with TIA/EIA-568-C.2 for performance specifications (Category 6A).

- a. CommScope
 - b. Superior Essex
 - c. Hubbell
 - d. Or Approved Equivalent
2. Shall meet the following specifications:
 - a. Maximum Operating Frequency of 500MHz
 - b. Maximum diameter of 0.285 in
 - c. Maximum DC Resistance of 7.61 Ohms/100m
 - d. Mutual Capacitance of 6.0 nF/100m at 1 kHz
 - e. Nominal velocity of propagation (NVP) of 66%
 - f. Maximum operating voltage of 80V
 - g. Conductor gauge of 23 AWG
 - h. Separator Type of Isolator
 - i. Maximum Pulling Tension of 11kg or 25 pounds
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications Plenum Rated: Type CMP
 - b. Communications Riser Rated: Type CMR

2.3 UNSHIELDED TWISTED-PAIR (UTP) CABLE TERMINATION HARDWARE

- A. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2. Cables shall be terminated with connecting hardware of same category or higher.
- B. Patch Panel: 24-Ports Discrete Distribution Module Panels
 1. Rack Type: EIA 19"
 2. 24 Ports, 1RU
 3. High Impact, Flame Retardant, Thermoplastic, Black Powder Coated Steel
 4. Cable Type: U/UTP (Unshielded)
 5. ANSI/TIA Category 6, 6A
- C. Patch Panel: 48-Ports Discrete Distribution Module Panels
 1. Rack Type: EIA 19"
 2. 48 Ports, 2RU
 3. High Impact, Flame Retardant, Thermoplastic, Black Powder Coated Steel
 4. Cable Type: U/UTP (Unshielded)
 5. ANSI/TIA Category 6, 6A
- D. Number of jacks per field: one for each four-pair UTP cable indicated.
- E. Patch Cords:
 1. All patch cords will be CommScope Brand booted CAT6 or CAT 6A based on application.
 2. Provide one patch cord per populated patch panel port.
 3. Coordinate patch cord lengths based on Direct Switch Patching from patch panel to switch.

4. Coordinate patch cord color with application and owner's IT representatives.

2.4 CONSOLIDATION POINTS

- A. Not used in this project.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: Rated for cable category, 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.2.
- B. Jacks and Jack Assemblies shall be modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals. Provide the telephone jack on top of the device and the Data jack on the bottom.

1. Unless otherwise specified by the customer, jack colors are:

- a. Voice and data jacks shall be blue.
- b. Security cameras jacks shall be red.
- c. Wireless access point jacks shall be orange.
- d. Access control systems jacks shall be violet.
- e. A/V equipment jacks shall be gray.
- f. Building Systems jacks shall be black.

- C. Workstation outlets: two-six (2-6) ports-connector in a single faceplate:

1. Plastic Faceplate in common areas, offices, and most public places: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
2. Metal Faceplate in mechanical, community, electrical, and high use areas: Stainless steel complying with requirements in Division 26 Section "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
4. Flush mounting jacks, positioning the cord at a 45-degree angle.
5. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.6 MULTI-USER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

- A. Not used in this project.

2.7 COAXIAL HORIZONTAL CABLE

- A. General Requirements for Cable and Connecting Hardware:

1. Cable shall be RG-6 with 18 AWG solid copper-clad center conductor.
2. Quad Shield with:
 - a. 60% aluminum braid inner shield
 - b. APA bonded tape inner shield

- c. 40% aluminum braid outer shield
 - d. APA bonded tape outer shield
 - 3. Nominal attenuation shall be:
 - a. .58 dB/100 ft at 5 MHz
 - b. 1.6 dB/100 ft at 55 MHz
 - c. 1.95 dB/100 ft at 83 MHz
 - d. 3.3 dB/100 ft at 250 MHz
 - e. 4.66 dB/100 ft at 500 MHz
 - f. 6.55 dB/100 ft at 1000 MHz
 - g. 8.13 dB/100 ft at 1500 MHz
 - h. 8.97 dB/100 ft at 1800 MHz
 - B. Patch Panel:
 - 1. Provide wall-mounted modular coaxial patch panel.
 - C. Terminate with Type F connectors.
- 2.8 SHIELDED TWISTED-PAIR CABLE (For AV Technologies)
- A. Description: Category 6, 100-ohm, 4-pair, shielded twisted-pair cable, blue.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-C.2 for performance specifications (Category 6).
 - 3. Shall meet the following specifications:
 - a. Maximum diameter of 0.285 in.
 - b. Maximum DC Resistance of 9.38 Ohms/100m
 - c. Mutual Capacitance of 5.6 nF/100m at 1 kHz
 - d. Nominal velocity of propagation (NVP) of 68%
 - e. Maximum operating voltage of 80V
 - f. Conductor gauge of 23 AWG
 - g. FTP construction consisting of a pair isolator, a core wrap, a shield and a drain wire.
 - B. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - 1. Communications Plenum Rated: Type CMP
 - 2. Communications Riser Rated: Type CMR
- 2.9 UNSHIELDED TWISTED-PAIR (UTP) CABLE TERMINATION HARDWARE (For AV Technologies)
- A. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2. Cables shall be terminated with shielded connecting hardware of same category or higher.
 - B. Patch Panel: 24-Ports Discrete Distribution Module Panels.

- C. Number of jacks per field: one for each four-pair cable indicated.

2.10 AUTOMATED INFRASTRUCTURE MANAGEMENT (AIM)

- A. Not used in this project.

2.11 GROUNDING

- A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI/TIA-607-C.
- C. Comply with NEC Article 250, where required.

2.12 LABELING

- A. Comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 EXECUTION

3.1 COMMUNICATIONS EQUIPMENT ROOMS

- A. Coordinate horizontal cabling installation with the General Contractor.
- B. The General Contractor or Architect will provide a Communications Equipment Rooms layout.
- C. Provide coordination directly with field technicians as required.

3.2 WIRING METHODS

- A. Install cables in raceways, cable trays except within consoles, cabinets, desks, and counters except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in un-finished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings. All cable shall be plenum-rated.
 - 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring Within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

- D. The use of Velcro type tie is recommended for bundling cables.

3.3 INSTALLATION OF PATHWAYS

- A. The intent of the installation of the TOs pathways is as follows:

1. Where ceilings are accessible, the raceway and entrance end fitting shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
2. Where ceilings are partially accessible, or if the Drawings and/or Specifications indicate installation of access panels, the raceway shall extend above the ceiling and the conduits installed above the ceiling in the room to the nearest hallway distribution system.
3. Where ceilings are inaccessible, or no ceilings exist, the raceway shall extend up as close to the ceiling as practical to allow installation of conduits as high as possible to the nearest hallway distribution system.
4. Where floor pathways are utilized, the raceway (or conduit) and entrance end fitting shall extend to the nearest floor hallway distribution system

3.4 HORIZONTAL DISTRIBUTION SYSTEMS

- A. Conduit System (Renovations only, where conduit exists) Not applicable to this project.

- B. Cable Tray System

1. Complete wall-mounted, raised access floor or suspended cable tray system and necessary accessories shall be provided as shown on plans. Install entire cable tray system in accordance with manufacturer's minimum installation practices and all local governing codes.
2. Coordinate installation of cable tray with other trades to allow a minimum of 12" above, 12" in front, and 12" below of clearance from piping, conduits, duct-work, etc. Allowance must be provided for access to the tray with reasonable room to work. Obstructions to the tray must be minimized and cannot block more than 6 feet of the tray at any point in the run
3. Submittal drawings, in the form of 8 1/2"x 11" catalog cut sheets, shall be provided for the following items: cable tray, fittings, accessories and load data.
4. Cable tray shall not be loaded beyond 60% of manufacturer's recommended load capacity.
5. Install wall mounted cable tray on both sides of hallway as shown on drawings and where applicable.
6. Where a new cable tray distribution system encounters a wall, install sufficient 4" EMT sleeves through the wall so cabling does not exceed 20% fill.
7. Where cable tray is exposed below ceiling, install the appropriate solid bottom inserts to conceal cables.
8. Install cable tray dropouts where large quantities of cables exit the distribution system.
9. Cable tray must be sized to facilitate enough growth capacity for migration cable plant to coexist in same tray as existing cable plant wherever possible.

- C. Communication Equipment Room Ladder Rack System

1. Install Telecom Room ladder rack within the room as shown on TN drawing set. Ladder rack shall extend over all equipment frames.
2. Ladder rack shall be 18" wide with rectangular steel tubing cross members welded at 9-

- inch intervals, or as noted on the drawings.
3. All open pathway/trays shall be installed a minimum of six (6) inches away from any light fixture or other source of EMI (Electromagnetic Interference).
 4. All pathways shall be grounded per NEC Article 250.
 5. Provide external grounding strap at expansion joints, sleeves and crossover and at other locations where pathway/tray continuity is interrupted.
 6. Support all pathways from building construction. Do not support pathways from ductwork, piping, or equipment hangers.
 7. Install ladder rack level and straight unless noted on the construction drawings.

3.5 STATION CONDUITS

- A. Station conduit is defined as conduit that originates at the TO within the walls or is exposed from a raceway and extends into the hallway distribution system.
- B. Provide station conduits from TOs to the hallway distribution systems consisting of 1" EMT minimum or appropriate size as shown on the drawings or as specified herein for installation of telecommunications cables.
- C. Provide an insulating press fit bushing on all telecommunications conduits including inter-connecting nipples and stub to distribution system. To prevent conflicts with other cables or conduits to cable tray, the conduit shall be stubbed not less than 6" above or below conduit/cable tray center line. Where space permits, every effort shall be made to bend station conduits down such that the flow of installed cables promotes the minimum length back to the Telecom Room and the least amount of bends in the cables. Bushings must be rated to be used in an environmental air handling space (Plenum).
- D. Manufacturer of insulating bushing on all telecommunication conduits shall be Arlington or approved alternate equal.
- E. Provide measured pull line in 12" increments in each empty conduit to hallway distribution system.
- F. Indelibly mark station conduit at hallway distribution end with Room number that conduit serves.
- G. The use of 90-degree electrical pulling elbows is prohibited.
- H. Do not include more than two 90-degree bends between pulling points when installing station conduit runs. If the path of the station conduits requires more than 180 degrees of total bends, installation of an appropriately sized junction box is required. See Division 26 Section "Raceway and Boxes for Electrical Systems for junction box requirements.
- I. Place an appropriately sized junction box in each individual station conduit run that exceeds 100 feet in length.
- J. The use of a third bend in a conduit is only acceptable if:
 1. The total conduit run is reduced by 15%.
 2. The conduit size is increased to the next trade size.
 3. One of the bends is located within 12" of the cable feed end.

3.6 JUNCTION BOX REQUIREMENTS FOR STATION CONDUITS

- A. If the station conduit route exceeds the 180 degree of total bends limitation, an appropriately sized junction box is required within a straight section of the conduit run.
- B. Each station conduit run requires a separate junction box. The sharing of a junction box by multiple conduits is prohibited.
- C. A junction box shall not be used in place of a bend. All junction boxes in station conduit paths shall be installed within a straight section of the conduit run.

3.7 TELECOM OUTLET (TO) BOXES

- A. New construction TO consists of one (1) 4-11/16" square by 2-1/4" deep flush mounted box.
- B. Each outlet box shall have an EMT conduit extended into the cable tray. Conduits size is as follows:
 - 1. For Outlets with 3 or less cables, use a 1" EMT conduit
 - 2. For Outlets with 4-6 cables, use a 1.25" EMT conduit
- C. For all other sizes, calculate fill ratio at 40% for proper sized conduit

3.8 INSTALLATION OF CABLES

- A. Comply with NECA 1-2015.
- B. General Requirements for Cabling:
 - 1. Comply with ANSI/TIA-568.0-D and ANSI/TIA-568.1-D.
 - 2. Comply with BICSI ITSIM.
 - 3. Terminate conductors: no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacture's limitations on bending radii, but not less than radii specified in ANSI/TIA-568.1-D. Install lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
 - 8. Do not splice cable between termination, tap, or junction points.
 - 9. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
 - 10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 - 11. Pulling Cable: Comply with ANSI/TIA-568-C.0. Monitor cable pull tensions.
- C. UTP Cable Installation

1. Comply with ANSI/TIA-568.0-D.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart. Stagger supports between 48 inches and 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil 6 feet long of cable with a diameter coil of not less than 12 inches below each feed point.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with ANSI/TIA-568.0-D and the BICSI TDMM for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
3. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.9 FIRESTOPPING

- A. In all buildings, floor/ceiling assemblies, stairs, and elevator penetrations must be sealed with a 2-hour fire stop assembly at a minimum, unless otherwise noted.
- B. Contact Owner's Representative to identify walls which are fire-rated construction. Walls must be sealed with a 2-hour fire stop assembly at a minimum.
- C. Communication pathways requiring fire stopping shall utilize removable/re-usable fire stopping putties for ease of Moves, Adds, and Changes.
- D. All fire stopping penetrations shall conform to the recommended practices listed in UL1479 or ASTM.

3.10 GROUNDING AND BONDING

- A. Comply with ANSI/TIA-607-C.

- B. Install grounding according to BICSI TDMM.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.11 LABELING

- A. Comply with ANSI/TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. For new installations with one Telecom Room per floor, numbering shall be following 1000-series numbering for 1st floor, 2000 series for 2nd floor, etc. Coordinate labeling scheme with owner's IT representative.
- C. For wireless access points (WAP), cables shall be terminated on a separate panel and labeling shall follow the WAP location i.e. if WAPs are located on the second floor, the cabling shall be labeled WAP-201, WAP-202, etc.
- D. For existing installation, labeling shall follow the existing scheme.
- E. Paint and label colors for equipment identification shall comply with ANSI/TIA-606-C for Class 2, level of administration, including optional identification requirements of this standard, as approved by the County.
- F. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for project.
- G. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Furnish electronic record of all drawings, in software and format selected by Owner.
- H. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each

connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

5. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

- I. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA-606-C.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.12 FIELD QUALITY CONTROL

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

- B. Perform tests and inspections.

1. Visually inspect cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with ANSI/TIA-568-C.2.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Cabling shall be tested as per clause 1.8 of this document.
4. Test instruments shall comply with ANSI/TIA-568-C.2. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration for UTP cabling and links for fiber optic cabling.

- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to what is proposed in the BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and sub-mitted.

- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

- F. Prepare test and inspection reports.

- G. Final testing and system acceptance:

1. Perform a walk thru with the RCDD that designed the system and observed all system testing.
2. Provide As-Built documents included in the Close-out documents, for owner use.
3. All certified test reports shall be evaluated before final acceptance of the system can be made.

END OF SECTION 27 15 13

SECTION 27 21 33 – DATA COMMUNICATIONS WIRELESS ACCESS POINTS

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or superseding any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Statement of Work: The work of this section includes, but is not necessarily limited to the following:
 - 1. Provide all materials and labor for the layout and installation of the wireless access point (WAP) antenna system in conjunction with the Telecommunications Infrastructure, within the project building(s) as per this document and the accompanying Drawings.
 - 2. Grounding requirements specified in this section may be supplemented by special requirements of systems described in other sections.
- B. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures, or codes as set forth by the authority having jurisdiction.
 - 4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:
 - 1. Section 27 05 28 Pathways for Communications Systems
 - 2. Section 27 05 36 Cable Trays for Communications Systems
 - 3. Section 27 15 13 Communications Copper Horizontal Cabling

1.4 RELATED WORK

- A. The Contractor shall coordinate WAP installation with cable conduits and raceways, WAP Outlet locations, and other devices, equipment, furniture, and finishes.
- B. Equipment and materials provided and installed by others, unless otherwise shown in this

Section or the Drawings, shall include but are not limited to:

1. Section 07 84 00 - Firestopping
2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
3. Section 26 05 29 – Hangers and Supports for Electrical Systems
4. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.5 DEFINITIONS

A. Regardless of their usage in codes or other industry standards, certain words or phrases, as used in the Drawings and/or the Specifications shall be understood to have the specific meanings as ascribed to them in the following list:

1. Contractor – Integrator or Installer who has been awarded the contract to perform the work under this section.
2. Shall is mandatory instruction.
3. Will is informative.
4. Should is advisory.
5. Provide – To supply, install, connect, and configure for safe intended normal operation.
6. Indicated, Shown, or Noted – As indicated on drawings or specifications.
7. Equivalent, Similar, or Equal – Equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
8. Reviewed, Satisfactory, Accepted, Approved, Directed – As reviewed and considered satisfactory, acceptable, approved, or directed by the Owner or Owner's Representative.
9. EMT – Electrical Metallic Tubing.
10. RMC – Rigid Metallic Conduit.
11. SMR – Surface Metal Raceway.
12. Raceway – Any enclosed channel for routing wire, cable, or TBB(s).
13. PBB – Primary Bonding Busbar (previously Telecommunications Main grounding Busbar, TMGB). There is typically one PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.
14. SBB – Secondary Bonding Busbar (previously Telecommunications Grounding Busbar, TGB). There is typically one SBB per telecommunications room. The SBB is connected to the PBB.
15. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBBs to SBBs.
16. BBC – Backbone Bonding Conductor (previously Grounding Equalizer, GE). A telecommunications bonding connection that interconnects TBBs.
17. TBC – telecommunications Bonding Conductor (previously Bonding Conductor for Telecommunications, BCT). Conductor that connects the telecommunications bonding infrastructure to the building's service equipment (power) ground.
18. RBB – Rack Bonding Busbar. Copper busbar installed on and bonded to equipment rack or cabinet, used to bond installed equipment via TEBC.
19. RBC – Rack Bonding Conductor. A telecommunications bonding conductor connecting equipment racks or cabinets and RBBs to the PBB or SBB within a Telecommunications space.
20. TEBC – Telecommunications Equipment Bonding Conductor. A bonding conductor used to connect equipment to an RBB or RBC.
21. TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBB to SBBs.
22. Pull Box – a metallic box with a detachable cover, used to enable pulling cable through conduit runs longer than 100' or where there are more than 180 degrees of bends.

- 23. Junction Box – a pull box where a feeder conduit transitions to multiple distribution conduits.
- 24. WAP – Wireless Access Point, an active network device used to broadcast Ethernet communication via Wi-Fi radio signals.
- 25. WAP Outlet – Telecommunications outlet used to support WAP. WAP shall be connected to WAP Outlet with appropriately sized patch cable(s).
- 26. RSSI – Received Signal Strength Indication.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:

- 1. Systems shall be installed in accordance with the latest revisions of all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State, and Municipal Building Codes and the codes and standards of all other Authorities Having Jurisdiction
- 2. American Standards Association (ASA)
- 3. ASTM International (ASTM)
 - a. ASTM E814 Standard Test Method for Fire Tests of Firestop Systems
- 4. International Code Council (ICC)
 - a. International Building Code (IBC) / BOCA National Building Code
- 5. Occupational Safety and Health Administration (OSHA)
 - a. Occupational Health and Safety Standards (Standards – 29 CFR)
- 6. Institute of Electrical and Electronic Engineers (IEEE)
 - a. IEEE C2 National Electric Safety Code (NESC)
- 7. National Fire Protection Agency (NFPA):
 - a. NFPA-70 National Electric Code (NEC)
- 8. National Electrical Manufacturers Association (NEMA)
 - a. NEMA 250 Enclosures for Electrical Equipment (100 Volts Maximum)
- 9. Telecommunications Industry Association (TIA):
 - a. TIA 568.1-D Commercial Building Telecommunications Infrastructure Standard
 - b. TIA-569-D Telecommunications Spaces and Pathways
 - c. TIA 606-C Administration Standard for Telecommunications Infrastructure
 - d. TIA 607-C Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises

10. BICSI:

- a. Telecommunications Distribution Methods Manual (TDMM), 13th Edition
- b. Information Technology Systems Installation Methods Manual, 6th Edition

11. Underwriters Laboratory

- a. UL 467 Grounding and Bonding Equipment
- b. UL 1479 Standard for Fire Tests of Penetration Firestops

1.7 SCOPE OF WORK REQUIREMENTS

- A. The Contractor shall provide Installation of Wireless Access Points and supporting hardware infrastructure that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code, and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.
- B. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations, and authorities having jurisdiction.
- C. The Contractor shall validate exact location and installation of the equipment, cables, connections, and component systems and coordinate installation with the Architect and/or Owner's Representative.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, or after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
- C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.9 PROJECT SCHEDULE

- A. Project schedule shall follow the Division 0 construction schedule

1.10 BID/TECHNICAL PROPOSALS

- A. Bid proposal shall follow Division 0 and the general contractor requirements for bidding.

1.11 SUBMITTALS

- A. In addition to the following, Submittals' requirements shall follow Division 0, and the General Contractor requirements for submittals.
- B. Action Submittals
 - 1. Submit floor plans with "heat maps" overlaid that show the results of the Contractor's AP Site Survey and wireless predictive modelling to indicate areas of coverage, interference, and extrapolated signal strength.
 - 2. Submit all proposed labelling materials and nomenclature for approval.
 - 3. Submit proposed WAP locations and installation types and materials.
- C. Closeout Submittals
 - 1. Operation and Maintenance Documentation:
 - 2. As-Built Drawings: At the completion of the project, the contractor shall submit complete records to the Owner / Project Manager, reflecting any changes that occurred during the process of construction.
 - a. Records shall be maintained at the project site and shall consist of:
 - 1) A minimum of one set of As-Built Drawings with redline markups reflecting any changes or deviation from the system as initially shown on Contract Documents, and clearly identified component labels and identifiers,
 - 2) A minimum of one full set of Specifications with all Addenda.
 - 3) Any and all related spreadsheets or documentation.
 - b. Keep Records at the job site and make available to Owner and/or Designer at all times.
 - c. Keep Records current throughout the progress of construction. "Current" is defined as not more than one (1) week behind actual construction.
 - d. Show identifiers for major infrastructure components on Drawings.

1.12 PROJECT CONDITIONS

- A. Verify conditions on the jobsite applicable to this work. Notify General Contractor and/or Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

1.13 QUALITY ASSURANCE

- A. Quality Assurance requirements shall follow Division 0 and the general contractor requirements for quality assurance.

1.14 PRE-INSTALLATION MEETING/SCHEDULE

- A. If applicable, Pre-installation meeting and schedule shall follow Division 0 and the general contractor requirements for meeting attendance.

1.15 FINAL INSPECTION AND TESTING / COMMISSIONING

- A. Inspection and testing requirements shall follow Division 0 and the general contractor requirements for inspection.

1.16 WARRANTY

- A. Warranty requirements shall follow Division 0 and the general contractor requirements for warranties for materials and labor.
- B. Unless otherwise specified, provide a Contractor-endorsed warranty against defects in materials and workmanship.
 - 1. Provide one year on site labor warranty.
 - 2. Provide 20 year material warranty.
 - 3. The Contractor Warranty period shall initiate upon equipment installation at the site.

1.17 INSTRUCTION OF OWNER PERSONNEL

- A. No instructions are required as part of this specification section.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All material shall be new unless otherwise noted in this specification.
- B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

- A. The sizes and quantities of all hardware, accessories, and materials shall be determined and installed by the Contractor based on the requirement to provide a complete predictive analysis and Access Point / Antenna installation for a Wireless Access System.

2.3 PRODUCTS

- A. Indoor Wireless Access Point (WAP)
 - 1. Specified and furnished by Owner.
- B. Indoor External Antennas
 - 1. Specified and furnished by Owner.
- C. Outdoor Wireless Access Point (WAP)
 - 1. Specified and furnished by Owner.

- D. Outdoor External Antennas
 - 1. Specified and furnished by Owner.
- E. Outdoor WAP Enclosure, Wall Mount
 - 1. Specified and furnished by Owner.
- F. Outdoor WAP Enclosure, Pole Mount
 - 1. Specified and furnished by Owner.
- G. WAP Mounting Bracket, Acoustic Ceiling Grid
 - 1. Specified and furnished by Owner.
- H. WAP Mounting Bracket, Horizontal Box Mount
 - 1. Specified and furnished by Owner.
- I. Firestopping Material:
 - 1. Must conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted testing agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of actual field conditions.
 - 2. Firestopping material that is used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
 - 3. Fire stopping material may be a re-entry mechanical system.
 - 4. Acceptable Manufacturers:
 - a. Hilti
 - b. 3M
 - c. EZ Path
 - d. Or approved equal
- J. Labels:
 - 1. As recommended in TIA-606-C - Permanently fastened and created by hand-carried label maker or a software-based label making system.
 - 2. Shall be pre-printed or laser-printed type.
 - 3. Handwritten labels are not acceptable.
 - 4. Where used for cable marking, a label with a vinyl substrate and white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable shall be provided. The label color shall be different than the cable jacket color.
 - 5. Where insert type labels are used, provide clear plastic cover over label.
 - 6. Acceptable Materials:
 - a. Hand-Carried label maker:
 - 1) Brady: ID Pro Plus
 - 2) Panduit
 - 3) Or approved equal

b. Labels:

- 1) Brady: Bradymaker Wire Marking Labels WML-511-292
- 2) Panduit
- 3) Ideal
- 4) Or approved equal

PART 3 EXECUTION

3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes, and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references, and codes listed above in Section 1.6 of this document. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Install WAPS, Antennas, Enclosures, patch cables, and components in a manner that fully complies with the NEC, TIA, BICSI and other references listed in these specifications.
- F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- G. Remove surplus material and debris from the job site and dispose of legally.

3.2 AP SITE SURVEY

- A. WAP Outlet locations are depicted on the Contract Drawings as a reference and may not indicate final location of WAP or WAP Outlet. Final locations of WAPs shall be determined upon completion of AP Site Survey. WAP Outlet locations may be adjusted in order to maintain close proximity to WAP.
- B. A full site survey of all areas of the building(s) where Wireless Network coverage is required shall be conducted in order to determine and document the exact number, placement, and coverage of WAP devices and the type of antenna required by each (if applicable) to provide full wireless network coverage.

1. Site survey shall include real-time spectrum analysis, interference assessment, and multi-

- band coverage analysis using same make and model WAP that owner shall provide.
2. Contractor shall produce layouts and "heat map" report based on survey.
3. Contractor shall perform and document the survey without additional cost to owner, working closely with Owner, GC, and Design Consultant.
4. Contractor cooperate with and provide Owner the opportunity to participate in Site Survey and Layout Design.
5. Provide 100% coverage of project area with a minimum of -67 dBm RSSI.

- C. Upon concurrence and approval of WAP design and layout, contractor shall provide installation of WAP.
- D. Coordination with Telecommunication pathways and infrastructure is required to ensure that WAP Outlet locations are accessible from and within reasonable distance from WAP location and that maximum allowable cable lengths are not exceeded.

3.3 INSTALLATION

- A. All WAPs shall be securely mounted using WAP manufacturer recommended installation kits and accessories designed specifically for the make and model of the WAP and the installation surface, type, and intended use.
- B. WAPs shall be installed in accordance with manufacturer's instructions and recommendations.
- C. WAPs shall be installed in a manner such that network, power patch cords, or cables are concealed from view and protected from damage or tampering.

3.4 COMMISSIONING

- A. Owner shall be responsible for designing, providing, and supporting all active network components of the Wi-Fi system, including, but not limited to:
 1. Switches
 2. Routers
 3. Controllers
 4. Servers
 5. PoE Injectors
 6. PoE Switches
- B. Owner shall be responsible for all programming, commissioning, tuning and testing of all Access Points and wireless network components following installation.

3.5 FIRESTOPPING:

- A. The Telecommunications Contractor shall maintain the fire rating of all penetrated fire barriers. Firestop and seal all penetrations made during the SCS installation.
 1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
 2. Install firestops in strict accordance with manufacturer's detailed installation procedure.
 3. Install firestops in accordance with fire resistance requirements, manufacturer's recommendations, local fire, and building authorities, and applicable codes and standards

referenced in PART 1-1.2 REFERENCES. Apply sealing material in a manner acceptable to the local fire and Authority Having Jurisdiction (AHJ).

3.6 LABELING:

- A. Label all Wireless Access Points in accordance with TIA-606-C and as per directed by the Owner.

3.7 CONSULTANT ACCEPTANCE TESTS

- A. Final Owner's Representative and/or consultant acceptance will be performed along with the acceptance of completed telecommunications systems.

END OF SECTION 27 21 33

SECTION 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation

1.2 SUMMARY

- A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
 - 1. Provide and cabling in support of future equipment per this document and the companion drawing and specification packages
- B. Additional contractor requirements
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of cable lengths and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the authority having jurisdiction.
 - 4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:
 - 1. Section 28 13 00 ALARM & ACCESS CONTROL
 - 2. Section 28 23 00 VIDEO SURVEILLANCE & CLOSED_CIRCUIT TELEVISION
 - 3. Section 28 05 28 CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

1.4 RELATED WORK

- A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for the routing of cables from future equipment, terminal locations, and pull boxes to system equipment racks and or wall fields.
- B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:

1. Section 07 84 00 – Firestopping
2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
3. Section 26 05 29 – Hangers and Supports for Electrical Systems
4. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.5 DEFINITIONS

- A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
1. The term “Contractor” – Integrator who has been awarded the contract to perform the work under this section.
 2. The terms “shall” is mandatory, “will” is informative, and “should” is advisory.
 3. “Provide” – To supply, install, connect, and configure, for safe intended normal operation.
 4. The terms “Indicated”, “shown”, or “noted” – As indicated on drawings or specifications.
 5. The terms “Equivalent”, “similar”, or “equal” – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
 6. The terms “Reviewed”, “satisfactory”, “accepted”, “approved”, “directed” – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner’s Representative.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS / CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
 - b. International Building Code / BOCA National Building Code
 - c. National Electrical Code (NEC)
 - d. American Standards Association (ASA)
 - e. Electronics Industries Association (EIA)
 - f. Institute of Electrical and Electronic Engineers (IEEE)
 - g. National Electrical Manufacturers Association (NEMA)
 - h. Occupational Safety and Health Administration (OSHA)
 - i. GPO Security Criteria Design Standard
 - j. General Services Administration PBS-P100 Facility Standards for the Public Buildings Service 2018 Edition 2010 ADA Standards for Accessible Design
 - k. Federal Information Processing Standard 201 Personal Identification Verification (PIV) of Federal employees and Contractors, March 2006
2. National Fire Protection Agency NFPA
 - a. NFPA-70 National Electric Code
 - b. NFPA-72 National Fire Alarm and Signaling Code
 - c. NFPA 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces

3. Underwriters Laboratories (UL)

- a. UL Listed- Underwriter's Laboratories Listed
- b. UL 83: Thermoplastic-Insulated Wires and Cables
- c. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
- d. UL 1655: Standard for Community-Antenna Television Cables
- e. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

4. ANSI / TIA / EIA:

- a. TIA 568-B.1: Minimum 4-Pair Sc-TP Patch Cable Bend Radius
- b. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
- c. TIA / EIA: 606a Telecommunications Infrastructure Standard
- d. TIA / EIA: 607 Grounding and Bonding Requirements
- e. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History

5. BICSI:

- a. BICSI ITSIM Ch. 4: Pulling Cable
- b. BICSI ITSIM Ch. 6: Cable Termination Practices

6. NECA

- a. 1-2015, Standard for Good Workmanship in Electrical Construction

1.7 SCOPE OF WORK REQUIREMENTS

- A. The Contractor shall provide cabling that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.
- B. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.
- C. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. The following is for a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.
- B. Materials:

1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. RS-232 cabling.
 - b. RS-485 cabling.
 - c. Low-voltage control cabling.
 - d. Control-circuit conductors.
 - e. Alarm wire and cable.
 - f. UTP Category cabling

1.9 RELATED WORK

A. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
- C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.11 PROJECT SCHEDULE

- A. Project schedule shall follow the division 0, construction schedule

1.12 BID/TECHNICAL PROPOSALS

- A. Bid proposal shall follow division 0, and the general contractor requirements for bidding.

1.13 PRE-BUILD AND FINAL SUBMITTALS

- A. Submittals requirements shall follow division 0, and the general contractor requirements for submittals.

B. Submit the following materials:

1. Product Data: Submit for each type of product indicated.
2. For all cable types, submit the following installation data for each used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.

C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

D. Maintenance Data: For wire and cable to include in maintenance manuals.

E. Submit cable test data per testing requirements in section 3.7 Contractor Testing and Commissioning.

1.14 PROJECT CONDITIONS

- A. Verify conditions on the jobsite applicable to this work. Notify General Contractor and or Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.

1.15 QUALITY ASSURANCE

- A. Quality Assurance requirements shall follow division 0, and the general contractor requirements for quality assurance

1.16 PRE-INSTALLATION MEETING/SCHEDULE

- A. If applicable Pre-installation meeting and schedule shall follow division 0, and the general contractor requirements for meeting attendance.

1.17 FINAL INSPECTION AND TESTING / COMMISSIONING

- A. Inspection and testing requirements shall follow division 0, and the general contractor requirements for inspection.

1.18 WARRANTY

- A. Warranty requirements shall follow division 0, and the general contractor requirements for warranties for materials and labor.

1.19 INSTRUCTION OF OWNER PERSONNEL

- A. No instructions are required as part of this specification section

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All material shall be new unless otherwise noted in this specification.
- B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

- A. Paint all wall and ceiling mounted infrastructure devices as directed by the Consultant/Architect.
- B. The Contractor is responsible for providing a complete structured cabling infrastructure.

2.3 PRODUCTS

- A. The quantities, types of cabling and accessories shall be determined and installed by the Contractor based on the requirement to provide a complete structured cabling solution

2.4 RS-232 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Polypropylene insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. PVC jacket.
 - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
 - 1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. Plastic insulation.
 - 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 - 4. Plastic jacket.
 - 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 - 6. Flame Resistance: Comply with NFPA 262.

2.5 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM.
 - 1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 - 2. PVC insulation.

3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

C. Paired Cable: NFPA 70, Type CMG.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

D. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test

PART 3 EXECUTION

3.1 INSTALLATION

A. General Requirements for Cabling:

1. Comply with all applicable NECA NEC, TIA/EIA standards.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated terminals.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
7. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the cable insulation. UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed.

C. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

D. Separation from EMI Sources:

1. Separation between cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- 4. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
- 5. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 CONNECTIONS

- A. Comply with specific device requirements in Section 28 13 00 - ALARM AND ACCESS CONTROL for connecting, terminating, and identifying wires and cables.
- B. Comply with specific device requirements in Section 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED CIRCUIT TELEVISION (CCTV) for connecting, terminating, and identifying wires and cables.

3.3 FIRESTOPPING

- A. Comply with requirements in Section 07 84 00, Penetration Fire-stopping.

3.4 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26, Grounding and Bonding for Electrical Systems.

3.5 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 26 05 53, Identification for Electrical Systems.

3.6 LABELING

- A. Wire and terminal strip labeling:
 - 1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
 - 2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
 - 3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
 - 4. Wiring designator shall be alphanumeric code, unique for each cable.
 - 5. Each cable type shall be labeled starting with different destinations (i.e. card reader series "CRxxx", DPS series "DPSxxx", etc.).
 - 6. On projects that have multi room connectivity the source and destination room numbers should be a portion of the the cable number indicting a cable that traverses between two rooms.
 - 7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.7 CONTRACTOR TESTING AND COMMISSIONING

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment, and labeling of all components.
 - 3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination.
 - a. Instruments used for continuity measurements shall have a resolution of 0.1 ohms and an accuracy of better than 0.1 percent of reading plus 0.3 ohms. A 500-volt megohmmeter shall be used for insulation resistance measurements.
 - 4. Coaxial Cable Tests: Comply with requirements of TIA testing practices and procedures.
- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass all tests and inspections.
- E. Prepare test and submit cabling testing / inspection reports for approval.

3.8 CONSULTANT ACCEPTANCE TESTS

- A. Owner's Representative and or consultant shall approve cabling testing / inspection reports.
- B. Owner's Representative and or consultant acceptance tests will performed along with the acceptance of completed systems as described in Section 28 13 00 - ALARM AND ACCESS CONTROL and or 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED CIRCUIT TELEVISION (CCTV)

END OF SECTION 28 05 13

SECTION 28 05 14 – FIRE ALARM CABLES AND CONDUCTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm wire and cable.

1.2 DEFINITIONS

- A. Building Control Circuits: As defined in NFPA 70, Article 725 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- B. CI: Circuit Integrity.
- C. Fire Alarm Circuit Integrity Cable: Cable used in fire alarm systems to ensure continued operation of critical circuits during a specified time under fire conditions.
- D. IDC: Initiating Device Circuit.
- E. NPLFA: Non-Power Limited Fire Alarm.
- F. PLC: Power Limited Circuit
- G. PLFA: Power-Limited Fire Alarm
- H. SLC: Signaling Line Circuit

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

PART 2 PRODUCTS

2.1 FIRE-ALARM WIRE AND CABLE

- 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. Allied Wire & Cable Inc.
 - 2. CommScope, Inc.
 - 3. Genesis Cable Products; Honeywell International, Inc.
 - 4. nVent (PYROTENAX).
 - 5. Rockbestos-Suprenant Cable Corp.
 - 6. West Penn Wire.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm installation.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Power-Limited Fire Alarm and Control: Solid copper. Stranded wiring must not be used.

3.2 INSTALLATION, GENERAL

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will

not damage cables or raceway.

- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.3 INSTALLATION OF FIRE-ALARM CABLES AND CONDUCTORS

- A. Comply with NECA 1 and NFPA 72.
- B. All fire alarm cables and conductors must be installed in metal pathway.
 - 1. Conduit must be rigid metal or electrical metallic tubing.
 - 2. Minimum conduit size: Trade size ¾-inch.
 - 3. Compression fittings must be used.
 - 4. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 5. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 6. Signaling Line Circuits: Power-limited fire-alarm cables may be installed in the same pathway as signaling line circuits when permitted by the alarm manufacturer.
- C. Wiring within Enclosures:
 - 1. Separate power-limited and non-power-limited conductors as recommended by manufacturer.
 - 2. Install conductors parallel with or at right angles to sides and back of the enclosure.
 - 3. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 4. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks.
 - 5. Mark each terminal according to system's wiring diagrams.
 - 6. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. All cable runs shall be continuous between devices without splices.
 - 1. All terminations of conductors shall be to screw-type terminal blocks. Wire nuts, wrap-on, crimp connectors and similar devices shall not be permitted.
 - 2. All connections shall be accessible for inspection and servicing and shall be clearly identified on the Contractor's record drawings.
- F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wir-

ing. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

- G. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
 - 1. Class 1 remote-control and signaling circuits, No. 14 AWG.
 - 2. Class 2 low-energy, remote-control and signal circuits, No. 14 AWG.
 - 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material.
- C. Comply with requirements in Section 28 31 11 "Addressable Fire Alarm System with One-Way Emergency Voice/Alarm Communications System" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

- A. Administrant for Tests and Inspections:
 - 1. Administer and perform tests and inspections.
- B. Tests and Inspections:
 - 1. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Inspect for correct identification.
 - c. Inspect cable jacket and condition.
 - d. Continuity test on each conductor and cable.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 28 05 13

SECTION 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Statement of Work: the work of this section included, but is not necessarily limited to the following:
 - 1. Provide and install boxes, conduits, pathway with pull strings per this document and the companion drawing package.
- B. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the authority having jurisdiction.
 - 4. Submittal information and provisions.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:
 - 1. Section 28 13 00 ALARM & ACCESS CONTROL
 - 2. Section 28 23 00 VIDEO SURVEILLANCE & CLOSED CIRCUIT TELEVISION

1.4 RELATED WORK

- A. The Contractor shall coordinate raceway / junction box locations for future equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.
- B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
 - 1. Section 07 84 00 - Firestopping

2. Section 26 05 26 – Grounding and Bonding for Electrical Systems
3. Section 26 05 29 – Hangers and Supports for Electrical Systems
4. Section 26 05 33 – Raceway and Boxes for Electrical Systems

1.5 DEFINITIONS

- A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
1. The term “Contractor” – Integrator who has been awarded the contract to perform the work under this section.
 2. The terms “shall” is mandatory, “will” is informative, and “should” is advisory.
 3. “Provide” – To supply, install, connect, and configure, for safe intended normal operation.
 4. The terms “Indicated”, “shown”, or “noted” – As indicated on drawings or specifications.
 5. The terms “Equivalent”, “similar”, or “equal” – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
 6. The terms “Reviewed”, “satisfactory”, “accepted”, “approved”, “directed” – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner’s Representative.
 7. The term “GRC” shall refer to Galvanized rigid steel conduit.
 8. The term “IMC” shall refer to Intermediate metal conduit.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
 - b. International Building Code / BOCA National Building Code
 - c. National Electrical Code (NEC)
 - d. American Standards Association (ASA)
 - e. Electronics Industries Association (EIA)
 - f. Institute of Electrical and Electronic Engineers (IEEE)
 - g. National Electrical Manufacturers Association (NEMA)
 - h. Occupational Safety and Health Administration (OSHA)
2. National Fire Protection Agency NFPA
 - a. NFPA-70 National Electric Code
 - b. NFPA-72 National Fire Alarm and Signaling Code
3. ANSI / TIA / EIA:
 - a. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
 - b. TIA / EIA: 606a Telecommunications Infrastructure Standard

- c. TIA / EIA: 607 Grounding and Bonding Requirements
- d. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History

1.7 SCOPE OF WORK REQUIREMENTS

- A. The Contractor shall provide infrastructure and pathway that shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements as applicable.
- B. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations and authorities having jurisdiction.
- C. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. The following is for a basic scope of work description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of infrastructure design is completely understood.
- B. Materials:
 - 1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
 - 2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. Wall boxes single gang
 - b. Wall boxes dual gang
 - c. Conduits and connectors
 - d. Conduit bushings
 - e. Pull boxes
 - f. Hangers and support for conduits and pull boxes.
 - g. Cable trays
 - h. J-Hooks
 - i. Wiring troughs
 - j. Floor Boxes

1.9 RELATED WORK

- A. Conduits:
 - 1. It is the Contractor's responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays as specified in part within this specification and associated drawing set.

B. Multi Discipline Devices:

1. It is the Contractors responsibility to review all device locations as specified in part within this specification and associated drawing set and to determine if electrical, telecommunications, and low voltage pathway requirements are met.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. All material shall be new unless otherwise noted in this specification.
- B. All materials must be UL listed or built to UL standards, where required.

2.2 GENERAL

- A. Paint all wall and ceiling mounted infrastructure devices as directed by the Consultant/Architect.
- B. The Contractor is responsible for providing a complete pathway infrastructure.

2.3 PRODUCTS

- A. The quantities of boxes, conduits and accessories shall be determined and installed by the Contractor based on the requirement to provide a complete pathway solution
- B. General: Raceways and boxes shall be constructed of the manufacturer's standard materials, as listed in published product information; types and sizes shall be as indicated or as required for the installation
- C. Metal Conduits and fittings:
 1. Empty conduit box system complying with sections 16050 and 16820.
 2. Not less than 3/4" conduit size and larger conduit sizes as indicated.
 3. Shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Shall comply with TIA-569-B.
 5. Manufacturers:
 - a. Southwire Company.
 - b. Thomas & Betts Corporation.
 - c. Western Tube and Conduit Corporation.
 - d. Wheatland Tube Company
- D. Non Metallic Conduits and fittings:
 1. Empty conduit system complying with sections 16050 and 16820.
 2. Not less than 3/4" conduit size and larger conduit sizes as indicated.
 3. Shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and

- marked for intended location and application.
- 4. Shall comply with TIA-569-B.
- 5. Manufacturers:
 - a. Allied Tube & Conduit; a Tyco International Ltd. Co.
 - b. Lamson & Sessions; Carlon Electrical Products.
 - c. Niedax-Kleinhuis USA, Inc.
 - d. RACO; a Hubbell company.
 - e. Thomas & Betts Corporation.

E. Outlet Boxes:

- 1. Empty outlet box system complying with sections 16050 and 16820.
- 2. 1 gang box – 2-1/8 inches deep by 2-1/8 inches high with 1 gang ring.
- 3. 2 gang box – 2-1/8 inches deep by 4-11/16 inches square with 2 gang ring.
- 4. 6" x 6" NEMA Type 1 enclosure
- 5. 8" x 8" NEMA Type 1 enclosure
- 6. 10" x 10" NEMA Type 1 enclosure
- 7. 12" x 12" NEMA Type 1 enclosure
- 8. Others as required or per manufacturer's recommendation
- 9. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 10. Manufacturers:
 - a. RACO; a Hubbell company.
 - b. Thomas & Betts Corporation.
 - c. Wiremold / Legrand.

F. Cover Plates

- 1. Comply with Section 260500 and 275116.
- 2. Provide blank plates for all outlet boxes that are not utilized for each phase.

G. Floor Boxes / Core Pokes:

- 1. Type: Unless otherwise indicated, floor boxes shall be fully adjustable, UL listed, CUL listed, scrub water approved and not less than 480 in³ in volume. Adjustment leveling feet shall provide 1/8 inch (minimum) vertical or angular (tilting) adjustment.
- 2. Cover Plates: Unless otherwise indicated, cover plates for floor boxes shall be made of heavy steel not less than 11-gauge thick and each shall be provided with a 0.25 inch aluminum ring (SLP-type) or flange permanently attached to the adjusting ring.
- 3. Floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Floor boxes shall be provided and configured to accept connection plates and defined in device schedules and plate details.
- 5. Manufacturers:
 - a. FSR
 - b. Wiremold / Legrand

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter.
- B. Install raceway and outlet box system continuous from outlet to junction box and to equipment location with no more than four (2) quarter bends (180 degrees total) without a pull box.
- C. Install raceway from outlet boxes to cable tray in corridor as indicated. Bush and ream conduit ends and terminate with insulated bushings. Clamp conduit to structure as required for proper support.
- D. Provide fittings as required and appropriate to the installation conditions.
- E. Install raceway from outlet boxes to accessible ceiling spaces. Bush and ream conduit ends and terminate with insulated brushings.
- F. Where cable tray/ladder is not utilized, make continuous runs from box to box with isolation from building systems as required.
- G. Install boxes as indicated or as necessary, complying with the manufacturer's written instructions, applicable requirements of codes and standards, and according to recognized industry practices. Finished installation shall have a 4 hour minimum fire rating.
- H. Knockouts: Open only knockouts which will be used for a conduit. Install tight fitting knockout closers in holes from which conduits have been removed.
- I. Box Supports: Fasten raceways and boxes securely in place, using any approved spring clips and other fasteners, required in Section 260529 - Supporting Devices.
- J. No Extension Rings: Install boxes which provide the required volume without the use of extension rings.
- K. Masonry Boxes: Install masonry boxes where boxes are recessed in wood, concrete block or brick or wood paneling. Saw-cut the opening for the boxes so that they will fit snugly in the opening. Install boxes with front edges flush with adjacent surfaces.
- L. Cast Metal Boxes: Install cast metal boxes with weatherproof covers under any of the following conditions:
 - 1. Exterior locations
 - 2. Where exposed to moisture
 - 3. In exposed rigid steel conduit systems
- M. Boxes for Receptacles: Shall be equipped with a grounding terminal screw.
- N. Boxes for Electronic Security, Signal and Alarm use: do not require a grounding terminal screw.
- O. Box Covers: Install blank box covers for all future infrastructure locations and pull boxes that are appropriate for the box, type of outlet and device, and with additional requirements as follows:
 - 1. For boxes recessed in gypsum wallboard, install raised device covers.

2. For exposed, surface mounted boxes, install covers deep drawn 1/2 inch, with height and width dimensions identical to the associated box.
3. For cast metal boxes, install gasketed, cast metal covers.

- P. Care for Insulation: Replace any thermal insulation cut or damaged during installation of boxes.
- Q. Contractor shall provide seismic bracing for appropriate infrastructure where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 FIRESTOPPING

- A. Comply with requirements in Section 07 84 00, Penetration Fire-stopping.

3.3 GROUNDING

- A. For low-voltage wiring and cabling, comply with requirements in Section 26 05 26, Grounding and Bonding for Electrical Systems.

3.4 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553, Identification for Electrical Systems.

3.5 LABELING

- A. Conduit Labeling:
1. Conduits shall be marked and or labeled as to indicate conduit destination, usage and device type. Contractor shall develop a conduit labeling scheme for approval by owner's representative and or consultant prior to implementation.

3.6 CONTRACTOR TESTING AND COMMISSIONING

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Visually inspect conduit labeling, bend radius and connections. Verify pull strings have been provided, conduits are free of debris, are deburred, and boxes are free of dirt and debris.
- C. Prepare test and inspection reports.

3.7 ACCEPTANCE TESTS

- A. Owner's Representative and or consultant shall approve conduit inspection reports.

- B. Owner's Representative and or consultant shall inspect conduits prior to concrete pours and or wall close in.
- C. Final Owner's Representative and or consultant acceptance will performed along with the acceptance of completed systems as described in Section 28 13 00 - ALARM AND ACCESS CONTROL and or 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED CIRCUIT TELEVISION (CCTV)

END OF SECTION 28 05 28

SECTION 28 13 00 - ALARM AND ACCESS CONTROL

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation.

1.2 SUMMARY

- A. Statement of Work: the work of this section includes, but is not necessarily limited to the following:
 - 1. Provide and install complete and operational Alarm (ALM) and Access Control System (ACS) as outlined in these specifications and related drawings and documentation requirements as set forth within this documentation.
 - 2. It is the responsibility of the Contractor to provide all wiring, plates, connections, and miscellaneous equipment for complete and operational system even if specified in this or other related documents or not.
- B. Coordination, provision, installation, inspection, testing, instruction, and warranties of the ALM and or ACS systems.
- C. All facilities, materials, equipment, transportation, and necessary labor for a complete and operational ALM and or ACS system.
- D. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturer's recommendations.
 - 4. Submittal information and provisions.
 - 5. Documented ALM and or ACS System testing procedures.
 - 6. Instruction of operating personnel.
 - 7. Manuals and provisions thereof.
 - 8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:

1. Section 28 23 00 - VIDEO SURVEILLANCE & CLOSED CIRCUIT TELEVISION
2. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY
3. Section 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

1.4 RELATED WORK

- A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.
- B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
1. Section 07 84 00 - FIRESTOPPING
 2. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
 3. Section 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
 4. Section 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

1.5 DEFINITIONS

- A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
1. The term "Contractor" – Integrator who has been awarded the contract to perform the work under this section.
 2. The terms "shall" is mandatory, "will" is informative, and "should" is advisory.
 3. "Provide" – To supply, install, connect, and configure, for safe intended normal operation.
 4. The terms "Indicated", "shown", or "noted" – As indicated on drawings or specifications.
 5. The terms "Equivalent", "similar", or "equal" – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
 6. The terms "Reviewed", "satisfactory", "accepted", "approved", "directed" – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner's Representative.
 7. The term "Professional grade" – Equipment that is intended for commercial use, use, and is rated for continuous 24-7 use.
 8. The term "User-friendly controls" – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
 9. The term "Labels" – refer to labels on audio-visual equipment as outlined in Section 3.4.
 10. The abbreviation "OFE" refers to items that are Owner Furnished Equipment
 11. The abbreviation "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment
 12. The abbreviation "VSS" refers to video surveillance system.
 13. The abbreviation "CCTV" refers to closed circuit television camera systems and components.
 14. The abbreviation "ALM" refers to an integrated alarm system and components.
 15. The abbreviation "ACS" refers to an integrated access control system and components.

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS AND/OR CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
 - b. International Building Code / BOCA National Building Code
 - c. National Electrical Code (NEC)
 - d. American Standards Association (ASA)
 - e. Electronics Industries Association (EIA)
 - f. Institute of Electrical and Electronic Engineers (IEEE)
 - g. National Electrical Manufacturers Association (NEMA)
 - h. Occupational Safety and Health Administration (OSHA)
 - i. GPO Security Criteria Design Standard
 - j. Federal Information Processing Standard 201 Personal Identification Verification (PIV) of Federal employees and Contractors, March 2006
 - k. GPO Furnished Criteria
2. National Fire Protection Agency NFPA
 - a. NFPA-70 National Electric Code in particular the following sections:
 - 1) Sect 300: Wiring in ducts plenums, and other air handling spaces
 - 2) Sect 318: Cable trays
 - 3) Sect 645: Electronic Computer / data processing equipment.
 - 4) Sect 760: Fire protection signaling system
 - 5) Sect 770: Optical fiber cables
 - 6) Sect 780: Closed-Loop and programmed power distribution
 - b. NFPA-71 Installation, Maintenance and use of Signaling Systems for Central Station Service.
 - c. NFPA-72 National Fire Alarm and Signaling Code
 - d. NFPA 72-D - Installations, Maintenance and Use of Proprietary Protective Signaling Systems
 - e. NFPA 75 Protection of Electronic Computer Data Processing Equipment
 - f. NFPA 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
3. IEEE
 - a. IEEE 802.3: STANDARD FOR LOCAL AREA NETWORKS
4. Underwriters Laboratories (UL)
 - a. UL Listed- Underwriter's Laboratories Listed
 - b. UL 83: Thermoplastic-Insulated Wires and Cables
 - c. UL 294: Access Control System Units / ULC Standard for Access Control Systems
 - d. UL 611: Central Station Burglar Alarm Units and Systems
 - e. UL 634: Standard for Connectors and Switches
 - f. UL 639: Standard for Intrusion Detection Units
 - g. UL 1076: Proprietary Burglar-Alarm Units and Systems

- h. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
 - i. UL 1635: Standard for Digital Alarm Communications System Units.
 - j. UL 1655: Standard for Community-Antenna Television Cables
 - k. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
 - l. UL 1950 Information Technology Equipment, including Electrical Business Equipment
5. ANSI / TIA / EIA:
- a. ANSI C2: NATIONAL ELECTRIC SAFETY CODE
 - b. ANSI X3T9.5 STANDARD FOR FIBER DISTRIBUTED DATA INTERFACE (FDDI)
 - c. TSB-67: TRANSMISSION PERFORMANCE FOR FIELD TESTING OF UTP CABLING SYSTEM
 - d. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
 - e. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
 - f. EIA RS-310-C Racks, Panel, and Associated Equipment
 - g. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures – Attenuation
 - h. TIA 568-B.1-2000 Telecommunications Standard
 - i. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
 - j. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
 - k. TIA / EIA: 606a Telecommunications Infrastructure Standard
 - l. TIA / EIA: 607 Grounding and Bonding Requirements
 - m. EIA/CEA: 861 A DTV Profile for Uncompressed High Speed Digital Interfaces.
 - n. TIA-862 Revision B, February 29, 2016, Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History
6. Video Coding Experts Group VCEG
- a. H.262[1] or MPEG-2 Part 2
 - b. H.263
 - c. H.264/MPEG-4 AVC
 - d. H.264 or MPEG-4 Part 10
 - e. H.265 or High Efficiency Video Coding (HEVC),
7. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.

1.7 SCOPE OF WORK REQUIREMENTS

- A. The Contractor shall provide an ALM and or ACS System.
- B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.

- C. The Contractor shall provide a complete and operational system configured and installed for user-friendly operation and low maintenance.
 - 1. Provide one adjustment and calibration of the ALM and or ACS systems, as directed by the Owner's Representative, before Final Acceptance.
 - 2. Provide one adjustment and calibration of the ALM and or ACS systems, as directed by the Owner's Representative, after Final Acceptance.
- D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.
- E. The contractor shall restore finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.
- F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations, and authorities having jurisdiction.
- G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.
- H. All finalized software affiliated with the equipment, including but not limited to, the DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.
- I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. The following is for a basic system description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.
- B. The ALM and or ACS Security System for the Location makes up the security hardware/software portion of the client's programmatic use requirements. The Security System will be a state-of-the-art system designed to comply with the requirements for an access control and proprietary alarm monitoring system.
- C. Materials:
 - 1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
 - 2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. Devices:

- 1) Access control panel (ACP)
 - 2) Card Reader (CR)
 - 3) Door Position Sensor / Switch (DPS)
 - 4) Door locks/lock with power supplies.
 - a) Electric Strike (ES)
 - b) Electric Lockset (EL)
 - c) Electrified Exit Hardware (QEL / EXH)
 - 5) Proximity Exit Sensor (PIR)
 - 6) Intelligent Field Panels (IFPs)
 - 7) Output relay control panels (RCP).
 - 8) Central Processing Unit (CPU)
- b. Modems and all related communication equipment.
 - c. Printers
 - d. All power supplies and transformers.
 - e. Master Deck, or workstation.
 - f. Computer(s)
 - g. Wire for readers and or panel communications connections.
- D. Provide and install all equipment, components, wire, cable, antennae, and associated mounting hardware as required to meet manufacture's specifications and documented installation procedures.
- E. All material and equipment shall be standard, regularly manufactured equipment. All systems and components shall be thoroughly tested and proven in actual field use. Where possible, all system components shall be from one manufacture. Whenever components are included from sources other than the manufacture of the system, the Contractor shall demonstrate and verify that the components are compatible, prior to the system acceptance, and shall provide to the Owner that use of such components will not void or impair the system warranty.
- F. The Security System will provide continuous year-round, 24 hours-per-day, 7 days-per-week operation. The major function of the Security System will be to provide controlled access, intrusion detection, surveillance and assessment and communications as required.
- G. The Security System will incorporate the necessary components to collect, transmit and process alarm, tamper and trouble conditions, advisories, and access requests in accordance with security procedures. The Security System will support the normal flow of authorized personnel and vehicles through controlled-access points to maintain facility operating efficiency.
- H. The Door Access System shall be a modular, networked access control system capable of handling large proprietary corporations with multiple sites, alarm monitoring. The system shall also allow for easy expansion or modification of inputs, outputs, and remote-control stations.
- I. The Door Access system shall be Tyco or Approved equal. The system shall be interfaced so that an Operator at the Security Desk.
- J. The system shall monitor, control, secure, track, and record any activity at any of the given door locations that are associated with the Door Access System. The System shall control the doors via the control center, and can independently operate if the main CPU fails to operate. The doors shall be secured by electronic strikes, and will either be controlled by card reader access, manual operation, software control, or by egress.

- K. The Contractor shall comply with all codes, licenses, and regulations for state, county, and/or local governing body. This includes but not limited to: fail safe operating, power failure, and interfacing with fire control system.
- L. The cards readers shall be placed and programmed so that the operator can easily operate the reader and enter the building. The motion egress and push button egress units shall be located and programmed so that it will allow for a user to exit the door, but will re-lock at a set time, and will not trigger for background motion.
- M. The main control computer shall be programmed to monitor all alarm input and output points. The CPU operator shall also be able to lock or unlock at door at any given time. The main CPU shall be where all programming shall be done to the system, and then downloaded to all associated panels.
- N. The system shall provide both supervised and non-supervised alarm point monitoring. Upon recognition of an alarm. The system shall be capable of alarming or disarming alarm points both manually and automatically, by the time of day, and by the day of the week.
- O. Access control functions shall include validation based on time of day, day of week, holiday scheduling, site code and card number verification, automatic or manual retrieval of cardholders' photographs, and access validation on positive verification of card or card and PIN.
- P. Alarm events with defined priorities shall be able to pop-up automatically in an Alarm event window for operator attention. The pop-up shall display the name of the event (reader, alarm point, card holder, or the system alarm), time, date, if a card event, the card number, type of event and cardholder's name. An event counter shall also display the number of times the event was reported to the Alarm event monitor prior to Acknowledgment or Clearing the event. Event instructions shall be made available by double clicking on the event.
- Q. The alarm event window shall allow the operator to initiate a physical response to the event as well as a written response. Responses shall include but not limited to: acknowledge, clear, open a preprogrammed floor plan, energize, de-energize, pulse, time pulse, add comment, shunt, or un-shunt.
- R. The system programming shall be user friendly, and capable of being accomplished by personnel with no prior computer experience.
- S. After installation, the Owner shall be able to perform hardware configuration changes. These hardware configuration changes shall include, but not limited to, door open time, door contact shunt time, point and reader names, when and where a cardholder is valid, and the ability to add or modify card databases as desired without the services of the Contractor or Manufacturer.
- T. System Monitoring and Control
 - 1. The Security Desk, located TBD, will be the focal point for monitoring and controlling Security System equipment. Since the Security Desk (TBD) may not be manned continuously, it will be able to operate unattended. When the Security Desk is not manned, security-related functions will be performed at an alternate TBD location. At a minimum, the Security Desk will contain an operator workstation with dual LCD monitors, a keyboard and mouse, a Closed-Circuit Television (CCTV) keyboard and a master intercom station. The location will be equipped with an operator workstation with a LCD monitor, a keyboard and mouse and a master intercom station. To preclude unauthorized use, the operator workstations will be protected by a multi-level password scheme. All operator log-on and

log-off transactions will be automatically stored in a historical file for future recall.

U. Data Processing and Storage

V. The processing and storage of system status and database information will be performed by the Access Control System (ACS) server to support the real-time operation of the Security System and for the initiation of system data and control signals in response to operator requests and software application programs. The ACS server will be rack-mounted in Telecom 314A. The ACS server will communicate with the operator workstations over the facility Local Area Network (LAN) via CAT6 cable.

1. To assure adequate expansion capability, ACS server working memory and archival storage will be provided with a spare capacity of at least 50 percent of initial requirements with provisions for a minimum growth capability of 100 percent of initial capacity.
2. To prevent unauthorized access and manipulation, the ACS server programs and databases will be protected by a multi-level password scheme

W. Signal Transmission

1. The Security System will support a distributed data collection and processing scheme. The ACS server will interface with ACS field equipment via Intelligent Field Panels (IFPs). The IFPs will be hardwired to all monitored and controlled-access point devices to collect and transmit status information to the ACS server for processing and/or storage. IFPs will be located in the Telecom Rooms on the third floor.
2. Interior IFPs and exterior IFPs within 290 feet of a LAN drop will communicate with the ACS server over the facility LAN via CAT6 cable. Exterior IFPs more than 290 feet from a LAN drop will communicate with the ACS server via fiber optic cable. If communications with the ACS server is disrupted, each IFP will have provisions to store a minimum of 5,000 authorized access transactions, off-normal events and monitored point resets locally. Upon restoration of communications, the IFPs will upload the stored data. Data uploading will not interfere with the real-time reporting of subsequent off-normal events and resets.
3. Video signals from interior CCTV cameras and exterior CCTV cameras mounted on the side of the building will be transmitted to the nearest dedicated Surveillance and Assessment System (SAS) network switch via CAT6 cable. A SAS Layer 3 network switch will be provided in the MDF Room. A SAS Layer 2 network switch will be provided in the third floor Telecom Room.
4. The design of the Security System will incorporate line supervision features to detect any attempt to compromise the signal lines between system components. The level of line security provided will meet or exceed the requirements for Grade AA service as defined in UL 1076.
5. IP master and remote intercoms within 290 feet of a LAN drop will communicate over the facility LAN via CAT6 cable. Exterior remote intercoms more than 290 feet from a LAN drop will communicate via fiber optic cable.

X. Controlled Access

1. The Security System will monitor and control selected doors within the facility based on the presentation of a valid cardkey at a card reader. Unauthorized access requests will be denied, and an advisory will be annunciated at the operator workstation(s). Card readers will utilize proximity technology. Each card reader will be provided with separate visual indications that access has been granted or denied. Access will be controlled by assigning any combination of controlled-access points to each individual for authorized access. Access may be further controlled by assigning a time zone for access at each controlled-

- access point. All access transactions will be archived.
2. Normally, access authorization decisions will be made locally at the associated IFP. Sufficient local memory will be provided to store all access authorization data for up to 500 individuals. Access authorization data will be automatically downloaded from the ACS server to each IFP, as appropriate. If authorization data for an individual requesting access is not found at the associated IFP, the ACS server will be queried for a decision.
 3. If an access request is authorized at a controlled-access door, the IFP will generate signals to unlock the associated electrical lock and shunt the associated door position switch to permit unalarmed entry. The door will relock, and the door position switch will be unshunted as soon as the door closes after entry. In the event the door/gate is not closed within a predetermined time period (programmable) a held open advisory will be annunciated at an operator workstation(s). Each controlled-access door/gate will be equipped with a request-to-exit sensor or exit pushbutton to shut the door position switch for unalarmed exit.

Y. System Programming

1. Database: The Contractor shall assist the Owner in setting up the system database requirements and formats. Forms to be utilized in collecting and entering all data shall be provided to the Owner by the Contractor. Written instructions on the use of all forms shall be included. Examples of the sequence of completion for all related forms shall be provided. The Owner shall be responsible for the actual data collection and entry to ensure a complete understanding of the system and its contents.
2. Programming: The Contractor shall initially configure the system in accordance with the design shown in the drawings. All access control requirements, alarm point definitions, camera/monitor, alarm point call up and in/out relationships, individual component descriptions, and any other programmable parameters required shall be as shown in the appropriate drawings and schedules. The Owner shall perform any additional programming with the assistance of the Contractor. All programming must be approved by Owner for approval before installation is started.

1.9 RELATED WORK

A. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and coordination drawings as required for proper communication and understanding between trades.
2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.

- C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.11 SCHEDULING

- A. The Contractor shall submit a schedule to the Owner for approval. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off of project. This schedule shall be submitted on Microsoft Project, both paper and electronic format, with submittals.
- B. It shall be the responsibility of the Contractor to coordinate the installation of the system to be compatible with the work of the other trades. The Contractor shall attend weekly progress meetings and provide continuous on-site project management.
- C. It shall be the responsibility of the Contractor to arrange with the Owner a mutually acceptable time for Acceptance Testing, based upon the dates provided in the Solicitation

1.12 PROJECT SCHEDULE

- A. All Requests For Information (RFI) shall be directed as outlined in Division 1.
- B. All bids must be received as outlined in Division 1.
- C. Hard copies of the bid proposals will be accepted as outlined in Division 1.
 - 1. Please provide bid submission per project bid instructions.

1.13 BID/TECHNICAL PROPOSALS

- A. The ALM and or ACS System Installer shall be experienced in the provision of systems similar in complexity to those required for this [project and shall at least meet the following criteria:
 - 1. The primary business of the Contractor/Installer shall be the installation of ALM and or ACS systems.
 - 2. At least five (5) years' experience with the specified equipment and systems.
 - 3. Experience with at least one project of similar size and complexity as outline in these specifications.
 - 4. Be an authorized dealer and service facility for the products specified and furnished.
 - 5. The Contractor shall provide personnel with extensive training for each system type and configuration.
 - 6. The Contractor shall maintain a fully staffed installation crew and service crew for maintenance and installation of the specified systems.
 - 7. Lead Installer shall have factory training in support of installed systems and equipment.
 - 8. Contractor shall demonstrate that the installation staff consists of certified security professionals.
 - 9. Final ALM and or ACS System configurations shall be approved by the Owner's Representative, Architect and Consultant.
 - 10. At the request of the Owner, Contractor shall demonstrate that he has:
 - a. Sufficient facilities and equipment for this work.

- b. Sufficient staff with the appropriate technical expertise and experience for this project.
- 11. All Bid proposals shall be valid for ninety (90) days from date received.
- 12. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment
- B. Provide a list of five (5) references with locations, names of contacts, and contact phone information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old.
- C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents and drawings, manufacturer requirements, and RFI responses as applicable.

1.14 PRE-BUILD AND FINAL SUBMITTALS

- A. Provide the following for approval sixty days after Notice to Proceed and prior to commencement of work:
 - 1. A complete list of all products to be incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
 - 2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
 - 3. Provide shop drawings as defined in the section below.
- B. Shop Drawings:
 - 1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of systems.
 - 2. All drawings shall be scaled appropriately but not less than 1/8" = 1'.
 - 3. Schematic detailed wiring diagrams showing interconnection of Contractor provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
 - 4. Show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling within housing.
 - 5. Show all A.C. power outlet locations and terminal strip locations within each equipment rack.
 - 6. Plans and sections of the building and adjacent grounds showing the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
 - 7. Patch panel layouts and labeling strips, including color schemes as necessary.
 - 8. Full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
 - 9. Provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate.
 - 10. Complete labeling schemes for all cabling and equipment components for the project.

Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.

11. A complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout with a t least a 20% oversize for project utilization for future system growth.
12. Provide a complete conduit riser and associated conduit plans for a complete conduit system. Include a Junction Box schedule showing type, size, mounting style, and location of each box.

C. Submittal Format: (PDF version)

1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes / lists of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive and or CD / DVD ROM.
8. Each submittal shall include a complete table of contents with the following information:
 - a. Project title and number.
 - b. Submittal number.
 - c. Date of submission.

D. Submittal Format: (Printed Option if specifically Required)

1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
6. Reference addendum or change order numbers as applicable.
7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information:
 - a. Project title and number.
 - b. Submittal number.
 - c. Date of submission.

1.15 PROJECT CONDITIONS

- A. Verify conditions on the jobsite applicable to this work. Notify Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions and submit drawings showing

how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

- A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys, and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.
- B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating Integrated Security Management Systems which include access control and alarm monitoring. Manufacture shall be able to similar installations rendering satisfactory service.
- C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.
 - 1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
 - 2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
 - 3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING/SCHEDULE

- A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.
- B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

1.18 FINAL INSPECTION AND TESTING / COMMISSIONING

- A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.6), the Consultant shall perform system(s) inspection and testing (as outlined in section 3.7).
- B. To assist the Consultant by providing a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the system(s).
- C. Process of testing the system(s) may necessitate moving and adjusting certain components such as PIR sensor and or glass break location adjustments.
- D. Testing will include operation of each camera and sub system and any components deemed necessary. Provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.
- E. In the event that further adjustments or work is required during testing, the Contractor shall continue his work until the system(s) is acceptable at no addition to the contract price. If approval is delayed due the defective equipment, and/or failure of equipment or installation to meet the requirements of this specification, the Contractor shall pay for additional time and expenses of the Owner at the rate specified by the Owner.

1.19 WARRANTY

- A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial one-year service contract.
- B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.
- C. The Contractor shall respond with remedy to a trouble call within twenty-four (24) hours after receipt of such a call, and shall provide a 24-hour service phone number. Uptime for system(s) shall be no longer than 24-hour period. All replacement parts/components shall be of equal or higher level for service.
- D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
- E. At least two routine inspection and adjustment visits will be scheduled for the first year. Submit reports to Owner.
- F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

1.20 INSTRUCTION OF OWNER PERSONNEL

- A. After final inspection and completion, provide instruction to Owner designated personnel on the operation and maintenance of the system(s).
- B. Develop an instructional course based on the use of the system(s) and manufacturer's

recommendations. Provide a minimum of five (5) hours of instruction. Arrange course so that operational and maintenance classes are separate.

- C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.
- D. Submit an outline of the course with sample instructional aids for approval thirty (30) days prior to scheduled instruction sessions.
- E. The training time shall not be less than a total of 32 hours, and shall consist of:
 - 1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
 - 2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
 - 3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel.
- F. The specified training schedule shall be coordinated with the Owner and will follow the training outline submitted by the Contractor as part of the submittal process.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Electronic component models shall be commercially available for a least one (1) year prior to bid, or be approved by the Consultant and or Owner's Representative.
- B. All equipment and material shall be new.
- C. All equipment must be UL listed or built to UL standards, where required.

2.2 GENERAL

- A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied unless a variance (separate document) is submitted and approved by the Owner's representative and or Consultant.
- B. System shall be installed and configured for simplicity of operation, with user-friendly controls.
- C. Provide product quantity as required for a complete and operable system. If any quantities are given, the Contractor shall provide at least the given amount. Some of the product listed under this section may not be required to fulfill the work as outlined.
- D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.

- E. Remove all manufacturer's nameplates or logos from product, as required, within the public site lines or spaces.
- F. Paint all wall and ceiling mounted devices as directed by the Consultant/Architect.
- G. The Contractor is responsible for providing a fully operational, turnkey ALM and ACS systems.

2.3 PRODUCTS

- A. The quantities of components shall be determined and installed by the Contractor based on the requirement to provide a fully operational Integrated Security Management System, as per the intent of the specification, and as shown on the drawings and recommended by the Manufacturer.

2.4 FRONT END SYSTEM

- A. For performance PC system configurations that require high availability, the manufacturer shall be consulted for appropriate custom PC system configuration
 - 1. Computer Specifications:
 - 2. Standard PC Specification:
 - 3. CPU shall be a Pentium 4 2.4 GHz
 - 4. RAM shall be 521 MB DDR SDRAM 333Mhz
 - 5. Hard disk shall be a 9GB SCSI or larger (Increased drive capacity shall be required in badging applications depending on image compression.)
 - 6. 3.5" floppy disk and CD drive
 - 7. Monitor shall be 17" 1024 x 768 true color or larger
 - 8. 2 button mouse (PS2 mouse preferred)
 - 9. Standard 101-keyboard layout and IBM-compatible keyboard
 - 10. 20 G, IDE Tape BU
 - 11. 2 serial communication ports
 - 12. 1 parallel port (2 parallel ports for badging)
 - 13. Microsoft Windows XP Professional, Windows 2000 Professional Service Pack or Windows NY 4.0 with Service Pack 6a
 - 14. Video Card
 - 15. CD Drive: 48x
 - a. Acceptable product:
 - 1) Microsoft CPU and components
 - 2) Or approved equal.

2.5 FRONT END SOFTWARE REQUIREMENTS

- A. Specifications for software:
 - 1. The System shall interface with the existing control access software.
 - 2. Monitor Display: The software shall display all system activity on a color monitor in real time, except for remote locations configured as dial-up. The software shall allow a WAV

- file to be played upon all alarm conditions. The software shall provide an acknowledge function for all incoming alarm messages that are defined for alarm acknowledgment.
3. Disk Storage: The software shall store user-selected activity on the hard disk. Report options shall recall selected history information from the hard disk. The user may request report information based on selected cardholders, specific areas and/or specific times. The software shall allow archiving by defined dates.
 4. English Descriptions: The software shall support descriptive names for all database entries. The card database shall include name, number, PIN, access level, status, activation, and expiration date or limited usage and 40 user-defined fields.
 5. Password Protection: The software shall provide multi-level password protection, with user-defined operator name/password combinations. Name/password log-on shall restrict operators to selected areas of the program. The software shall allow the assignment of operator levels to define the system components that each operator has access to view, operate, change, or delete.
 6. Action Messages: The software shall allow recall of user created text messages upon any condition.
 7. Graphics: The software shall allow recall of user created screen graphics, upon alarm/trouble/normal conditions. These graphics shall allow the user to go from a general area to a specific area in various layers or stages and shall allow the user to monitor and control system devices from floor plans.
 8. Manual Panel Control: The software shall allow manual control of selected inputs, outputs, and groups of outputs. Manual panel control shall include pulse, timed pulse, and energize/de-energize or return to time zone options for output points and shunt/unshunt or return to time zone options for input points. For entrances and readers manual control shall include but be limited to Lock, Un-Lock, Shunt, Un-Shunt, Pulse and Timed Pulse.
 9. Acceptable product:
 - a. DSX Access Control with a BCD Video Nova series JC1360MACS-P2K
 - b. Or approved equal

2.6 CONTROL PANEL

A. Power Distribution Panel

1. 12VDC/6A power for controllers
2. Battery backup for controllers
3. Lock power 12VDC-8A/24VDC-4A-8A
4. UL 294/UL 1076
5. AC loss/low battery supervisory outputs
6. Fire override input and output
7. Acceptable product:
 - a. DSX 1040PDP and DSX 1022 back up batteries,
 - b. Or approved equal

B. Intelligent Control Panel

1. Scalable architecture 2-8 doors
2. TCP/IP communications
3. Individual intelligence
4. 512K RAM/512K flash ROM
5. UL 294/UL 1076

6. 240+ card and keypad formats
7. FIPS/TWIC card compatibility
8. Real time processing and communications
9. Integrated power supply and distribution
10. 16 inputs for standard point monitoring
11. 16 inputs for door position and exit request
12. All inputs support two, three, and four state monitoring
13. Form C relays 8
14. UL294 listing/CE certification
15. Relay output ratings 5 amp-30VDC
16. Access controlled entry points card reader or keypad-8
17. Nema type 1 equivalent enclosure with lift off hinged door, lock/key and tamper switch.
18. Time codes: 63 per controller
19. Elevator support: 32 groups
20. Communication support: RS-485; 20mA
21. Acceptable product:

- a. DSX -1048
- b. Or approved equal

C. Intelligent Control Panel

1. 32 programmable inputs
2. 2, 3, 4 state monitoring
3. 4 digital outputs
4. UL 294/UL 1076
5. LED status for each input
6. Flexible I/O linking
7. Non-volatile memory available
8. 512K RAM/ 512K flash ROM
9. Scalable architecture
10. 16 inputs for door position and exit request
11. Acceptable product:

- a. DSX -1044
- b. Or approved equal

D. Quadraplexor

1. RS-232/RS-485 inputs
2. Master to Slave star wiring
3. 4 RS-485/4 wire outputs
4. 1 rs-232/3 wire output
5. RS-232 diagnostic output
6. Protocol independent
7. TCP/IP communications
8. Powered by integral power supply or controller
9. Relays are time programmable for automatic control
10. Acceptable product:

- a. DSX 1035 Quadraplexor
- b. Or approved equal

E. Master Comm Interface

1. RS-232 to RS-485 converter
2. RS-232 input via terminal block or DB25 female
3. RS-485 output via terminal block
4. 12VDC power by controller
5. Over voltage protection
6. UL 294/ UL 1076
7. Status LEDs
8. Protocol independent
9. Acceptable product:
 - a. DSX -MCI
 - b. Or approved equal

F. LAN Comm Interface

1. DSX/PC master/L85 software
2. Auto-sensing 10/100/auto duplexing
3. RS-232/RS485 controller communication
4. UL 294/ UL 1076
5. Dial up modem backup-optional
6. Static or dynamic IP communications
7. Acceptable product:
 - a. DSX –LAN(M)
 - b. Or approved equal

G. Proximity Readers:

1. Mullion sizes and switch plate size
2. ADA compliant built-in audible buzzer
3. Tamper detect output (can erase security keys)
4. Maximum read range: 2.5-3.75 inches (6.4-9.5 cm)
5. Frequency: 13.56 MHz
6. ISO Standard Support: 14443A, 14443B, and 15693
7. Power Supply Type: Linear or Switching(Ripple,30 MHz, max 50mVss)
8. Operating Voltage Range: 5 – 16 VDC (works down to 4.25 VDC)
9. Acceptable product:
 - a. Allegion aptiQ
 - b. Or approved equal

H. Ceiling Exit Button:

1. Door monitor with sounder alert
2. Sequential logic inputs
3. Internal vertical pointability
4. Wrap around coverage pattern with precise pattern control
5. Up to 64 seconds adjustable latch time
6. Selectable relay trigger mode
7. Selectable fail safe or fail secure modes
8. Acceptable product:

- a. Bosch DS160
- b. Or approved equal

I. Magnetic Door Contacts:

- 1. Designed specifically for use in steel doors
- 2. Special ribbed sides allow for easy installation
- 3. Rugged unibody construction for maximum durability and reliability
- 4. Regular, wide gap, SPDT, DPDT, and high security models available
- 5. Rare earth magnet designed for steel door with top channel
- 6. Acceptable product

- a. Sentrol 1078/78C
- b. Or approved equal

J. Surface Mount Magnetic Door Contacts:

- 1. Wide gap for decreased installation time
- 2. Fewer false alarms
- 3. SPDT, DPDT, and high security
- 4. Acceptable product:

- a. GE 2500 series
- b. Or approved equal

K. Power Supply

- 1. Meets IEC61000-4
- 2. Power factor corrected
- 3. Level B EMI
- 4. Universal input
- 5. Acceptable product:

- a. LAMBDA SWS Series
- b. Or approved equal

2.7 PLATES AND PANELS

- A. Provide plates and panels as described in the drawings and as required for a fully operable system.
- B. Custom plated shall be 1/8" thick aluminum, standard EIA sizes, brushed black anodized finished unless otherwise noted.
- C. Plastic plates are not allowed.
- D. Lettering shall be in all caps and numbers engraved with a color contrasting to the base material with a minimum size of 0.25".
 - 1. Font Size shall be 1/8"

- a. Font Style shall be Helvetica

- E. Acceptable manufacturers of custom plates and panels:

- 1. RCI Custom
- 2. Panel Authority
- 3. Whirlwind

2.8 PROPOSED SUBSTITUTIONS

- A. Where specific equipment is described, it is not the intention to discriminate against the products of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.
- B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve/disapprove all substitutions.
- C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.9 CABLES AND WIRING

- A. Shielded cables located in raceways shall have aluminum foil shield with drain wire.
- B. Plenum Rated / Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.
- C. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.
- D. Provide cabling compliant with Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY.
- E. Provide the following cabling types as required for a fully operable system:
 - 1. Communication outlet cables: 18 AWG 2 conductor shielded – West Penn 293
 - 2. Control cables: 18 AWG 2 conductor shielded – West Penn 293
 - 3. Antenna / CATV cable: RG-6 Quad Shield minimum refer to FCC / Cable provider recommendations as required.
 - 4. Precision video cable: Belden 8281 as required.
 - 5. Trunk video cable (RG6): West Penn Wire 841 (S).
 - 6. Trunk video cable (RG11): West Penn Wire 821.
 - 7. Video drop cable (RG6 Plenum): West Penn Wire 25841.
 - 8. Trunk video cable (RG11 Plenum): West Penn Wire 25821.
 - 9. 9-conductor 22AWG. communications cable: Belden 9945.

10. 9-conductor 18AWG. communications cable: Belden 83659.
11. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
12. F/UTP Category 6 Cabling West Penn Wire 254246AF
13. Shielded Twisted pair HDBaseT Cabling Extron XTP DTP 24

PART 3 EXECUTION

3.1 INSTALLATION

- A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.
- B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.
- C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.
- D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.
- E. Contractor shall mount all equipment, mounting brackets, plates, and panels, plumb and level.
- F. Contractor shall follow all applicable standards including ASIS Commission on Standards and Guidelines documentation as a basis of design, fabrication, construction, and Performance Verification.
- G. Contractor shall provide shaft locks or security covers on non-user operated equipment having front panel access.
- H. Contractor shall permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.
- I. Contractor shall validate bracing or blocking for proper mounting and safety.
- J. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

- A. Equipment Enclosures / Racks:
 1. Install all applicable equipment in racks and or wall mounts according to manufacturer's recommendations and product application.
 2. Provide adequate ventilation, thermal management, and temperature-controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
 3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
 4. Allow a minimum of 20% open rack space to support future expansion.

5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
6. Locate operator useable equipment and patch panels at an appropriate operating height.
7. Key all door locks for each housing type (front, rear) alike.
8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for any cable management is prohibited.
11. The use of tie wraps for network and optical fiber cabling is prohibited
12. Provide nylon braided sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Video Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tielines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Unshielded Twisted Pair UTP / STP RJ-45 Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:

1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:

1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:

1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
2. Provide logical and legible cable and wiring labels permanently attached for easy identification to each cable on both ends.
3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
4. Wiring designator shall be alphanumeric code, unique for each cable.
5. Each cable type shall be labeled starting with different destinations (i.e. mic series "Mxxx", speaker series "Sxxx", etc.).
6. On projects that have multi room connectivity the source and destination room numbers should be the prefix for the cable number indicating a cable that traverses between two rooms.
7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 PERFORMANCE STANDARDS

- A. All provided devices / equipment shall meet and or exceed published manufacturer's specifications and be compliant with the outlined salient capabilities as described in section 2, and be compatible with all applicable standards and configurations

3.6 CONTRACTOR TESTING AND OR COMISSIONING

- A. Prior to energizing or testing the system, ensure the following:

1. Execution: Activate all alarm or other output devices that are in the system for proper operation, including supervisory and trouble circuit tests.
2. Report: A checkout report for each piece of equipment shall be prepared by the Contractor and submitted to the Owner, one copy of which shall be registered with the equipment manufacturers. This report shall include a complete listing of every device, the date it was tested and by whom, and the results and date tested (if failure occurred during any previous tests). The final test reports shall indicate that every device tested successfully. Submit two typed copies of the test reports on 8 ½" x 11" papers, in a neatly bound folder to the Owner for approval. Failure to comply with this will result in a delay of final testing and acceptance.
3. All products are installed in a proper and safe manner per the manufacturer's instructions.
4. Insulation and shrink tubing are present where required.
5. Dust, debris, solder, splatter, etc. is removed.
6. Cable is dressed, routed, and labels and all connections are consistent with regard to polarity.
7. All labeling has been provided and installed.
8. All products are neat, clean, unmarred and securely fastened.
9. All debris has been cleaned and removed from the site.
10. All electronic devices are properly grounded.

B. Perform the following test. Record all results in the final project manual.

1. Test each AC power outlet for proper connections for hot, neutral, and ground.
2. Measure and record the DC resistance for the technical ground in the equipment racks and console. Resistance should be 0.15 ohms or less.
3. After the testing report and as-built drawings have been approved by the Owner's representative, the completed system shall be tested in the presence of the Owner's representative.
4. Acceptance of the system shall require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day period with a 99% system on-line reliability. Should major equipment failure occur, the Contractor shall replace component(s) and begin another ninety (90) day test period. This test shall not start until the Owner has obtained beneficial use of the system. If the requirements provided in the paragraph above are not completed within six (6) months after beginning the tests described therein, the Contractor shall replace the System with another one from approved Manufacturer, and the process shall be repeated until final acceptance of the System and its equipment by the Owner.
5. Once the final test is complete, each purchased spare component must be inserted into the System and the System tested in potentially affected areas again to insure complete functionality. The original removed parts will become the System spares.

C. Input Verification Test: (Composite video)

1. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
2. Perform complete system operation to verify proper system operation.
3. In a similar manner, check any other inputs or tie-lines as appropriate.

D. Input Verification Test: (IP Cameras)

1. Verify video stream presence on network and verify resolution and color depth settings.
2. Configure IP address for each stream to multi-image processor and to recorder as specified.
3. Perform complete system operation to verify proper system operation.
4. In a similar manner, check any other cameras or streaming devices as appropriate.

E. Notification:

1. Once all of the above is complete, the system is ready for inspection. Formally notify the Owner's representative and or consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and configurations will be conducted at the time of inspection.

3.7 CONSULTANT ACCEPTANCE TESTS

- A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.6 has been completed and the test results have been received and reviewed by the consultant and or owner's representative.
- B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.

- C. Checklist items within this list will be verified by visual and or audible methods as part of normal use case operational scenarios, with the assumption that the contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per section 3.6 above.
- D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
 - 1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
 - 2. The operation of all system equipment shall be demonstrated by the contractor.
 - 3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all control processors for any evaluation and adjustments (tuning) activities by the consultant.
 - 4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
 - 5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
 - 6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
 - 7. 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 consultant.
- E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION 28 13 00

SECTION 28 23 00 - VIDEO SURVEILLANCE (VSS) & CLOSED CIRCUIT TELEVISION (CCTV)

PART 1 GENERAL

1.1 REFERENCE TO OWNER'S GENERAL CONDITIONS

- A. The Owner's / Project General Conditions shall be considered part of this Specification. Unless this Section contains statements, which are more definitive or more restrictive than those contained in the Owner's General Conditions, this Specification shall not be interpreted as waiving or overruling any requirements expressed in the General Conditions documentation

1.2 SUMMARY

- A. Statement of Work: The work of this section includes, but is not necessarily limited to the following:
 - 1. Provide and install complete and operational Video Surveillance System (VSS) and or Closed Circuit Television (CCTV) System as outlined in these specifications and related drawings and documentation requirements as set forth within this documentation.
 - 2. It is the responsibility of the Contractor to provide all wiring, plates, connections, and miscellaneous equipment for complete and fully operational system even if specified in this or other related documents or not.
 - 3. Included spaces / systems
 - a. Third level Indoor IP Cameras
 - b. Third level Outdoor IP Cameras
 - c. Recording and IP camera monitoring
 - d. Network switch(s) for IP camera connectivity.
 - e. H.264 / H.265 video server and storage array.
- B. Coordination, provision, installation, inspection, testing, instruction, and warranties of the VSS and or CCTV systems.
- C. All facilities, materials, equipment, transportation, and necessary labor for a complete and operational VSS and or CCTV system.
- D. Additional contractor requirements:
 - 1. Required licenses and permits including any required bonding or insurance requirements that comply with general conditions of specifications and contract documentation.
 - 2. Verification of dimensions and conditions at the job site.
 - 3. Installation in accordance with the contract documentation, applicable installation procedures or codes as set forth by the state or county of the project or manufacturer's recommendations.
 - 4. Submittal information and provisions.
 - 5. Documented Camera System testing procedures.
 - 6. Instruction of operating personnel.
 - 7. Manuals and provisions thereof.
 - 8. Maintenance and warranties.

1.3 RELATED DOCUMENTS

- A. General: Comply with all Contract Documents.
- B. Related specification sections:
 - 1. Section 28 13 00 - ALARM & ACCESS CONTROL
 - 2. Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY
 - 3. Section 28 05 28 - CONDUITS AND PATHWAY FOR ELECTRONIC SAFETY

1.4 RELATED WORK

- A. The Contractor shall coordinate with Electrical Contractor on raceway / junction box locations for equipment and routing of cables / raceway from equipment, terminal and pull boxes to system equipment racks and or wall fields.
- B. Related Work: Equipment and materials provided and installed by others, unless otherwise shown in this Section or the Drawings, shall include but are limited to:
 - 1. Section 07 84 00 - FIRESTOPPING
 - 2. Section 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
 - 3. Section 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS
 - 4. Section 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

1.5 DEFINITIONS

- A. Regardless of their usage in codes or other industry standards, certain words or phrases as used in the Drawings or Specifications for the Work, shall be understood to have the specific meanings as ascribed to them in the following list:
 - 1. The term “Contractor” – Integrator who has been awarded the contract to perform the work under this section.
 - 2. The terms “shall” is mandatory, “will” is informative, and “should” is advisory.
 - 3. “Provide” – To supply, install, connect, and configure, for safe intended normal operation.
 - 4. The terms “Indicated”, “shown”, or “noted” – As indicated on drawings or specifications.
 - 5. The terms “Equivalent”, “similar”, or “equal” – equal in materials, size, color, design, and efficiency of specified product, conforming to base bid manufacturer selections.
 - 6. The terms “Reviewed”, “satisfactory”, “accepted”, “approved”, “directed” – As reviewed, satisfactory, accepted, approved, or directed by the Owner or Owner’s Representative.
 - 7. The term “Professional grade” – Equipment that is intended for commercial use, use, and is rated for continuous 24-7 use.
 - 8. The term “User-friendly controls” – Touch screen graphical user interface (GUI) or other graphical controls that are intuitively configured for ease of use in a logical, easily recognizable, configuration that utilizes industry standard symbols wherever applicable.
 - 9. The term “Labels” – refer to labels on audio-visual equipment as outlined in Section 3.4.
 - 10. The abbreviation "OFE" refers to items that are Owner Furnished Equipment
 - 11. The abbreviation "OFCI" refers to items that are Owner Furnished Contractor Installed Equipment
 - 12. The abbreviation “VSS” refers to video surveillance system.
 - 13. The abbreviation “CCTV” refers to closed circuit television camera systems and

- components.
14. The abbreviation "ALM" refers to an integrated alarm system and components.
 15. The abbreviation "ACS" refers to an integrated access control system and components

1.6 REFERENCE STANDARDS, REFERENCE MATERIALS / CODES

A. Applicable Codes and Standards:

1. Systems shall be installed in accordance with the latest applicable revisions pertaining to all applicable national, state, and local codes and standards including, but not limited to the following:
 - a. Federal, State and Municipal Building Codes and all other Authorities having jurisdiction
 - b. International Building Code / BOCA National Building Code
 - c. National Electrical Code (NEC)
 - d. American Standards Association (ASA)
 - e. Electronics Industries Association (EIA)
 - f. Institute of Electrical and Electronic Engineers (IEEE)
 - g. National Electrical Manufacturers Association (NEMA)
 - h. Occupational Safety and Health Administration (OSHA)
 - i. General Services Administration PBS-P100 Facility Standards for the Public Buildings Service 2018 Edition 2010 ADA Standards for Accessible Design
 - j. GPO Security Criteria Design Standard
 - k. GPO Furnished Criteria
2. National Fire Protection Agency NFPA
 - a. NFPA-70 National Electric Code in particular the following sections:
 - 1) Sect 300: Wiring in ducts plenums, and other air handling spaces
 - 2) Sect 318: Cable trays
 - 3) Sect 645: Electronic Computer / data processing equipment.
 - 4) Sect 760: Fire protection signaling system
 - 5) Sect 770: Optical fiber cables
 - 6) Sect 780: Closed-Loop and programmed power distribution
 - b. NFPA-71 Installation, Maintenance and use of Signaling Systems for Central Station Service.
 - c. NFPA-72 National Fire Alarm and Signaling Code
 - d. NFPA 72-D - Installations, Maintenance and Use of Proprietary Protective Signaling Systems
 - e. NFPA 75 Protection of Electronic Computer Data Processing Equipment
 - f. NFPA 262: Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
3. IEEE
 - a. IEEE 802.3: STANDARD FOR LOCAL AREA NETWORKS
4. Underwriters Laboratories (UL)

- a. UL Listed- Underwriter's Laboratories Listed
 - b. UL 83: Thermoplastic-Insulated Wires and Cables
 - c. UL 294: Access Control System Units / ULC Standard for Access Control Systems
 - d. UL 611: Central Station Burglar Alarm Units and Systems
 - e. UL 634: Standard for Connectors and Switches
 - f. UL 639: Standard for Intrusion Detection Units
 - g. UL 1076: Proprietary Burglar-Alarm Units and Systems
 - h. UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords
 - i. UL 1635: Standard for Digital Alarm Communications System Units.
 - j. UL 1655: Standard for Community-Antenna Television Cables
 - k. UL 1666: Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts
 - l. UL 1950 Information Technology Equipment, including Electrical Business Equipment
5. ANSI / TIA / EIA:
- a. ANSI C2: NATIONAL ELECTRIC SAFETY CODE
 - b. ANSI X3T9.5 STANDARD FOR FIBER DISTRIBUTED DATA INTERFACE (FDDI)
 - c. TSB-67: TRANSMISSION PERFORMANCE FOR FIELD TESTING OF UTP CABLING SYSTEM
 - d. TIA-222 STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS
 - e. EIA 232-D Interface between Data Terminal Equipment and Data Circuit-Termination Equipment Serial Binary Data
 - f. EIA RS-310-C Racks, Panel, and Associated Equipment
 - g. TIA-455-78 Revision B, FOTP-78 IEC 60793-1-40 Optical Fibres - Part 1-40: Measurement Methods and Test Procedures – Attenuation
 - h. TIA 568-B.1-2000 Telecommunications Standard
 - i. TIA-568-C.2 BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS
 - j. TIA/EIA-569-A-1995 (Commercial Building Standard for Telecommunications Pathways and Spaces)
6. TIA / EIA: 606a Telecommunications Infrastructure Standard
- a. TIA / EIA: 607 Grounding and Bonding Requirements
 - b. EIA/CEA: 861 A DTV Profile for Uncompressed High Speed Digital Interfaces.
 - c. TIA-862 Revision B, February 29, 2016 Structured Cabling Infrastructure Standard for Intelligent Building Systems Document History
7. Video Coding Experts Group VCEG
- a. H.262[1] or MPEG-2 Part 2
 - b. H.263
 - c. H.264/MPEG-4 AVC
 - d. H.264 or MPEG-4 Part 10
 - e. H.265 or High Efficiency Video Coding (HEVC),
- B. References to codes and standards called for in the Specifications refer to the latest edition, amendments, and revisions to the codes and standards in effect on the date of these Specifications.

1.7 SCOPE OF WORK REQUIREMENTS

- A. The Contractor shall provide a VSS and or CCTV System compatible with the Owner's existing system and operations as applicable.
- B. The Contractor shall provide equipment that, where required, shall conform to the applicable requirements of the Underwriters Laboratories, Inc., local codes, the National Electrical Code and any other governing codes. Such items shall bear a label or mark indicating their conformance to the above requirements.
- C. The Contractor shall provide a complete and operational system configured and installed for user-friendly operation and low maintenance.
 - 1. Provide one adjustment and calibration of the VSS and or CCTV systems, as directed by the Owner's Representative, before Final Acceptance.
 - 2. Provide one adjustment and calibration of the VSS and or CCTV systems, as directed by the Owner's Representative, after Final Acceptance.
- D. On-site factory technical support shall be provided, if necessary, to assure optimized configuration and performance of installed equipment and systems.
- E. The contractor shall restore finish hardware to original condition including painting, ceiling modifications, and attachments as specified in Division 09 Finishes. All finishes shall be approved by the Architect and or Owner's Representative.
- F. Installation work shall be in compliance with all Contract Documents, all applicable standards, governing codes, regulations, and authorities having jurisdiction.
- G. The Contractor shall validate exact location and installation of the equipment, power, conduit, and raceway systems and coordinate exact location and installation of the equipment, power, conduit, and raceway systems with the Architect and or Owner's Representative.
- H. All finalized software affiliated with the equipment, including but not limited to, the DSP, Control System, etc. is the property of the Owner and will be provided on labeled CDs or electronic media for archival purposes at project acceptance.
- I. The Contractor shall supply all control software, programming service codes, programming notes, files interactive source codes, all media and associated software, touch panel design, all passwords, licenses, dangles and "keys" or other associated control or programming items at no additional cost to the Owner at commissioning.

1.8 SYSTEM DESCRIPTION AND REQUIREMENTS

- A. The following is for a basic system description and is not intended to be exhaustive in nature and is not complete for proper installation or operation of system. The specification and the Bid Set drawings need to be fully reviewed together to ensure design intent and listing of design intent equipment is completely understood.
- B. The VLS and or CCTV System for the Location makes up the security hardware/software portion of the client's programmatic use requirements. The Security System will be a state-of-the-art system designed to comply with the requirements for video surveillance systems.

C. Materials:

1. Furnish and install at locations that show the specified equipment to provide a completely operational Integrated Security Management System without additional cost to the Owner.
2. The following list of main items of the installation shall not be considered to be all-inclusive:
 - a. Cameras fixed indoor and outdoor
 - b. Cameras 360 degree view indoor
 - c. All power supplies and transformers.
 - d. Master Deck, or workstation.
 - e. Computer(s)
 - f. Camera control software
 - g. Camera control surface.
 - h. Wire for cameras and network communications connections.
 - i. Provide indoor ceiling mounted fixed view IP cameras with PoE connectivity. (CAM1)
 - 1) Provide mounts and hardware as required.
 - j. Provide Video Management Software (VMS)
 - 1) Provide interface for viewing of cameras from both PCs and from portable devices.
 - 2) Provide live monitoring and camera controls.
 - 3) Provide interface with owner's existing wired IP cameras.
 - k. Provide all power supplies and transformers as required.
 - l. Computer(s)
 - m. Camera control software and network IP interface
 - n. Wire for cameras and network communications connections.

D. System Description:

1. The VSS and or CCTV System is a wide camera system with motion detection cameras installed in the various areas as located on the third floor. The same camera system shall be utilized in both indoor and outdoor cameras. The outdoor cameras shall be mounted in such a way as to allow proper site lines for coverage of the outside perimeter of the building and the entry points into the building. The camera system shall allow for expansion beyond the camera capacity as shown on the drawings and shall allow easy user interfacing for camera control. The outdoor cameras shall be a fixed unit. The outdoor fixed cameras shall be IP and have a resolution of 1080P. All interior cameras shall be fixed and have a resolution of 720P. The interior cameras shall also be IP based. There shall also be cameras located inside the elevator cabs.
2. The cameras will be controlled via the Owner's new/existing VSS and or CCTV system and use the existing NVR or video recorders.

1.9 RELATED WORK

A. Conduits:

1. It is the Contractors responsibility to review all conduit runs, junction boxes, and electrical outlet cable trays provided and installed under Division 26 and provide fit-up and

coordination drawings as required for proper communication and understanding between trades.

2. Provide a written acceptance of all field conditions or a list of any discrepancies within ten (10) working days from Notice to Proceed.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. The Contractor shall carefully control handling and installation of all items which are not immediately replaceable, so that completion of the work will not be delayed by hardware or equipment losses before, during, and after installation. The Contractor is responsible for all items until Final Acceptance.
- B. The Contractor shall, prior to installation, protect exposed surfaces with material which is easily removed without marring finishes.
- C. The Contractor shall, without cost to the Owner, replace any products damaged during storage or handling.

1.11 SCHEDULING

- A. The Contractor shall submit a schedule to the Owner for approval. The schedule shall show sequence of work, etc. from time of Notice to Proceed to final sign off of project. This schedule shall be submitted on Microsoft Project, both paper and electronic format, with submittals.
- B. It shall be the responsibility of the Contractor to coordinate the installation of the system to be compatible with the work of the other trades. The Contractor shall attend weekly progress meetings and provide continuous on-site project management.
- C. It shall be the responsibility of the Contractor to arrange with the Owner a mutually acceptable time for Acceptance Testing, based upon the dates provided in the Solicitation

1.12 PROJECT SCHEDULE

- A. All Requests For Information (RFIs) shall be directed as outlined in the Division 1.
- B. Hard copies of the bid proposals will be accepted as outlined in the Division 1.
 1. Please provide bid submission per project bid instructions.
- C. The opening of the bid proposals will be as outlined in the Division 1.

1.13 BID/TECHNICAL PROPOSALS

- A. The VSS and or CCTV System Installer shall be experienced in the provision of systems similar in complexity to those required for this [project and shall at least meet the following criteria:
 1. The primary business of the Contractor/Installer shall be the installation of VSS and or CCTV systems.

2. At least five (5) years' experiences with the specified equipment and systems.
 3. Experience with at least one project of similar size and complexity as outline in these specifications.
 4. Be an authorized dealer and service facility for the products specified and furnished.
 5. The Contractor shall provide personnel with extensive training for each system type and configuration.
 6. The Contractor shall maintain a fully staffed installation crew and service crew for maintenance and installation of the specified systems.
 7. Lead Installer shall have factory training in support of installed systems and equipment.
 8. Contractor shall demonstrate that the installation staff consists of certified security professionals.
 9. Final VSS and or CCTV System configurations shall be approved by the Owner's Representative, Architect and Consultant.
 10. At the request of the Owner, Contractor shall demonstrate that he has:
 - a. Sufficient facilities and equipment for this work.
 - b. Sufficient staff with the appropriate technical expertise and experience for this project.
 11. All Bid proposals shall be valid for ninety (90) days from date received.
 12. Any deviations from specified equipment must be explained in full detail including reasons for any deviations and product comparisons to the originally specified product. Submission of said comparisons does not constitute acceptance of changes and in fact may be declined. If substitutions are rejected/declined, Contractors bid may be rejected for "non-responsiveness" unless a bid has been supplied with "as-specified" equipment
- B. Provide a list of five (5) references with locations, names of contacts, and contact phone information with brief system descriptions and dollar amounts for each reference. References shall be no more than three (3) years old.
- C. Provide a detailed equipment list in Microsoft Excel format (both hard copy and electronic) showing Item Number, Item Description, Manufacturer, Part Number, Quantity, and Price. This equipment list shall be generated from this document, related project documents, drawings, manufacturer requirements, and pre bid RFI responses as applicable.
- 1.14 PRE-BUILD AND FINAL SUBMITTALS
- A. Provide the following for approval sixty days after Notice to Proceed and prior to commencement of work:
1. A complete list of all products to be incorporated within the work with all quantities listed. Each product shall be listed with specification section references in Excel format.
 2. Complete functional diagrams of each system required for a complete and operational system with descriptive narratives of any deviations from the specified system design.
 3. Provide shop drawings as defined in the section below.
- B. Shop Drawings:
1. Shall not be smaller than 24"x36" and shall be sized as appropriate for thorough understanding of systems.
 2. All drawings shall be scaled appropriately but not less than 1/8" = 1'.

3. Schematic detailed wiring diagrams showing interconnection of Contractor provided components and fabricated products, wiring and cabling diagrams depicting cable types, and device designators. Each component shall have a unique designator and use same designator throughout the project.
4. Show location of all equipment in racks, consoles, or on tables, with complete dimensions, wire routing, and cabling within housing.
5. Show all A.C. power outlet locations and terminal strip locations within each equipment rack.
6. Plans and sections of the building and adjacent grounds showing the location of all installed equipment such as loudspeakers, racks, consoles, plates/panels, antennas, (etc.).
7. Patch panel layouts and labeling strips, including color schemes as necessary.
8. Full fabrication detail of custom enclosures and millwork indicating dimensions, material, finish, and openings for equipment.
9. Provide complete drawings for all fabricated plates and panels. Drawings shall include dimensional locations of components, component type, engraving information, plate color information, and a complete bill of materials for each plate.
10. Complete labeling schemes for all cabling and equipment components for the project. Include font size and styles along with a sample cable label and equipment label. All labeling shall be consistent within the project scope.
11. A complete wire schedule showing source and destination and indicating conduit location and sizing. Provide conduit sizing and layout with a t least a 20% oversize for project utilization for future system growth.
12. Provide a complete conduit riser and associated conduit plans for a complete conduit system. Include a Junction Box schedule showing type, size, mounting style, and location of each box.

C. Submittal Format: (PDF version)

1. Arrange product data in alphanumeric order by system type and room indicate on cut sheet the options provided.
2. Separate major groupings Use multiple volumes / lists of content
3. Index product data sheets by manufacturer and model or part number.
4. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.
5. Reference addendum or change order numbers as applicable.
6. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
7. Provide via pdf, posted to FTP, thumb drive.
8. Each submittal shall include a complete table of contents with the following information:
 - a. Project title and number.
 - b. Submittal number.
 - c. Date of submission.

D. Submittal Format: (Printed Option if specifically Required)

1. Each submittal shall be in three-ring binders no larger than 3" spines and sized for 150% of material enclosed. Use multiple volumes if necessary.
2. Arrange product data in alphanumeric order by system type and room.
3. Separate major groupings with labeled binder tabs.
4. Index product data sheets by manufacturer and model or part number.
5. Each submittal shall include a unique numbering scheme and be numbered in consecutive order.

6. Reference addendum or change order numbers as applicable.
7. Reference specification section, part, article, paragraph, and/or drawing reference as applicable.
8. Each submittal shall include a complete table of contents with the following information
 - a. Project title and number.
 - b. Submittal number.
 - c. Date of submission.

1.15 PROJECT CONDITIONS

- A. Verify conditions on the jobsite applicable to this work. Notify Owner's Representative in writing of discrepancies, conflicts, or omissions promptly upon discovery.
- B. If conditions exist on the jobsite which make it impossible to install work as shown on the drawings or detailed in the specifications, recommend solutions, and submit drawings showing how the work may be installed as well as an adjusted new schedule to the Consultant and Owner for approval.

1.16 QUALITY ASSURANCE

- A. Provide and maintain an effective Quality Control program and perform sufficient inspections, surveys, and tests of all items of work, including those of other trades, to ensure compliance with the contract documents. Furnish appropriate facilities, accurately calibrated instruments and testing devices required to perform the quality control operations and with sufficient work forces to cover the installation operations within the actual installation sequences. Coordinate this work with the quality control requirements of other technical Sections of the Specifications and with requirements of the Contractor and governing authorities having jurisdiction.
- B. Manufacturer Qualifications: All system components shall be furnished by the manufactures of established reputation and experience who shall have produced currently operating Integrated Security Video Surveillance Systems which include access control and alarm monitoring. Manufacture shall be able to similar installations rendering satisfactory service.
- C. Bidder Qualifications: The bidder shall furnish in writing to the Owner proof of compliance with the manufacturer's system installation certification program.
 1. Hold all legally required state contractor's licenses necessary to accomplish the installation and activation of the described system at the facilities indicated. Contractor shall submit copies of licenses to the Owner prior to the start of work.
 2. Have a local office staffed with factory-trained technicians, fully capable of engineering, supervision installation, and system start-up. Providing the Owner training, and servicing hardware and software for systems of similar complexity and function as the system described in this specification.
 3. Indicate complete and total compliance with the provisions of this specification by letter, signed by an officer of the corporation, or a principal if other ownership currently exists. This letter shall also clearly identify any exceptions to specification requirements.

1.17 PRE-INSTALLATION MEETING/SCHEDULE

- A. Prior to the start of the work, and at the Owner/Consultant's direction, meet at the project site to review methods and sequence of installation, special details and conditions, standard of workmanship, testing and quality control requirements, job organization and other pertinent topics related to the work. The meeting shall include the Contractor, Contractor's Project Manager, the Owner/Consultant, and the General Contractor. Inspection and testing services (if any) and any other sub-Contractors whose work requires coordination with this work shall be coordinated.
- B. A Conduit/Wiring Analysis shall be conducted at the Pre-Installation Meeting. The Contractor shall submit "as-built" drawings locating all existing conduit runs, junction boxes, and electrical outlets. Show location and type of all special receptacle boxes and plates to be supplied and/or modified by the Contractor. Verify and inspect all necessary conduits and outlets. Provide with the submittals, a list of all conduits, boxes, and power changes necessary for installation of systems in each location.

1.18 FINAL INSPECTION AND TESTING / COMMISSIONING

- A. Upon completion of installation and Contractor testing and commissioning (as outlined in sections 3.6), the Consultant shall perform system(s) inspection and testing (as outlined in section 3.7).
- B. To assist the Consultant by providing a minimum of one person for inspection and two persons for testing who are familiar with all aspects of the system(s).
- C. Process of testing the system(s) may necessitate moving and adjusting certain components such as camera aiming and or focus / iris adjustments.
- D. Testing will include operation of each camera and sub system and any components deemed necessary. Provide required test equipment, tools, and materials required to perform necessary repairs and/or adjustments.
- E. In the event that further adjustments or work is required during testing, the Contractor shall continue his work until the system(s) is acceptable at no addition to the contract price. If approval is delayed due the defective equipment, and/or failure of equipment or installation to meet the requirements of this specification, the Contractor shall pay for additional time and expenses of the Owner at the rate specified by the Owner.

1.19 WARRANTY

- A. All equipment provided by the Contractor shall be installed per manufacturer's specifications and warranted by the Contractor for a period of one (1) year from the date of written acceptance to meet all performance requirements outlined herein. Warranties shall not be pro-rated. For all Owner-provided equipment, include pricing for an initial one-year service contract.
- B. During the warranty period, no charges shall be made for any labor, equipment, or transportation to maintain performance and functions.
- C. The Contractor shall respond with remedy to a trouble call within twenty-four (24) hours after receipt of such a call, and shall provide a 24-hour service phone number. Uptime for system(s) shall be no longer than 24-hour period. All replacement parts/components shall be of equal or

higher level for service.

- D. Equivalent replacement equipment shall be temporarily provided when immediate on-site repairs cannot be made.
- E. At least two routine inspection and adjustment visits will be scheduled for the first year. Submit reports to Owner.
- F. Provide a separate price for an optional yearly service contract for five (5) years, to begin at the end of the initial warranty and service contract. Provide details on coverage and options.

1.20 INSTRUCTION OF OWNER PERSONNEL

- A. After final inspection and completion, provide instruction to Owner designated personnel on the operation and maintenance of the system(s).
- B. Develop an instructional course based on the use of the system(s) and manufacturer's recommendations. Provide a minimum of five (5) hours of instruction. Arrange course so that operational and maintenance classes are separate.
- C. The training plan or class shall include detailed sections outlines and related reference materials. The Owner personnel shall be able to utilize these materials in the subsequent training of their co-workers.
- D. Submit an outline of the course with sample instructional aids for approval thirty (30) days prior to scheduled instruction sessions.
- E. The training time shall not be less than a total of 32 hours, and shall consist of:
 - 1. Three periods: Sixteen (16) hours during normal day shift for system operators. Specific scheduled shall be established at the convenience of the Owner. The sixteen hours shall be broken down into several sections.
 - 2. Eight (8) hours of system training shall be provided to Owner supervisory personnel so that they are familiar system operation.
 - 3. Eight (8) hours of system maintenance familiarization training shall be provided to Owner's telecommunications personnel.
- F. The specified training schedule shall be coordinated with the Owner and will follow the training outline submitted by the Contractor as part of the submittal process.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Electronic component models shall be commercially available for a least one (1) year prior to bid, or be approved by the Consultant and or Owner's Representative.
- B. All equipment and material shall be new unless otherwise noted in this specification.

- C. All equipment must be UL listed or manufactured to meet or exceed UL standards, where required.

2.2 GENERAL

- A. All equipment shall be professional grade and rated for continuous duty. Basic guidelines have been prepared with manufacturer names, makes, and model numbers included as minimum performance requirements. These must be satisfied unless a variance (separate document) is submitted and approved by the Owner's representative and or Consultant.
- B. System shall be installed and configured for simplicity of operation, with user-friendly controls.
- C. Provide product quantity as required for a complete and operable system. If any quantities are given, the Contractor shall provide at least the given amount. Some of the product listed under this section may not be required to fulfill the work as outlined.
- D. Regardless of the length or completeness of the descriptive paragraphs listed herein, each device shall meet published manufacturer's specifications.
- E. Remove all manufacturer's nameplates or logos from product, as required, within the public site lines or spaces.
- F. Paint all wall and ceiling mounted devices as directed by the Consultant/Architect.
- G. The Contractor is responsible for providing a fully operational turnkey system.

2.3 PRODUCTS

- A. The quantities of components shall be determined and installed by the Contractor based on the requirement to provide a fully operational Integrated Security VSS and or CCTV System, as per the intent of the specification, and as shown on the drawings and recommended by the Manufacturer.

2.4 CAMERAS

- A. Fixed IP Camera 1080P (90 Degree)
 - 1. 1080p HD images up to 60 fps*1
 - 2. Approximate 1/3 inches, high sensitivity MOS image sensor
 - 3. Maximum Screen Size is 1,980 x 1,080* @30 fps, H.264 * Used by super resolution technology
 - 4. Multiple H.264 (High profile) streams (max. 4 streams) and JPEG streams ensure simultaneous real time monitoring and high-resolution recording.
 - 5. High sensitivity with Day/Night(ICR*: WV-SFN311A, Electrical: WV-SFN310A) function: WV-SFN311A: 0.01 lx (Color), 0.003 lx (B/W) at F1.6 *ICR: IR Cut filter Removal
 - 6. New camera attachment bracket allows an easy camera installation toward all four directions.
 - 7. Provide compatible ceiling mount bracket.
 - 8. Acceptable product:

- a. Panasonic WV-SFN311A with Panasonic WVQ174B
- b. Or approved equal

B. Outdoor fixed IP Camera 1080P (90 Degree)

- 1. 1080p HD images up to 60 fps
- 2. Approximate 1/3 inches, high sensitivity MOS image sensor
- 3. Maximum Screen Size is 1,980 x 1,080* @30 fps, H.264 * Used by super resolution technology
- 4. Multiple H.264 (High profile) streams (max. 4 streams) and JPEG streams ensure simultaneous real time monitoring and high-resolution recording.
- 5. High sensitivity with Day/Night (ICR*: WV-SFV311A, Electrical: WV-SFV310A) function: WV-SFV311A : 0.01 lx (Color), 0.003 lx (B/W) at F1.6 *ICR: IR Cut filter Removal
- 6. New camera attachment bracket allows an easy camera installation toward all four directions.
- 7. ABF (Auto Back Focus) ensures easy installation.
- 8. Face Super Dynamic technology ensures clear face image.
- 9. Lens distortion compensation for the distorted images can be adjusted 256 steps.
- 10. Electronic sensitivity enhancement: Auto (Up to 16/30s) / OFF
- 11. Selectable light control modes: Outdoor scene, Indoor scene (50 Hz) / Indoor scene (60 Hz), Fix shutter Indoor scene (50 Hz/60Hz): Flicker caused by fluorescent lightning will be automatically compensated.
- 12. 2x extra optical zoom at 640 x 360 resolution
- 13. 2x, 4x digital zoom controlled by browser
- 14. VMD (Video Motion Detection) with 4 programmable detection areas, 15 steps sensitivity level and 10 steps detection size
- 15. Privacy Zone can mask up to 8 private areas, such as house windows and entrances/exits.
- 16. With wall mount bracket
- 17. Acceptable product:

- a. Panasonic WV-SFV311A with Panasonic PWM484S
- b. Or approved equal

C. Fixed IP Camera 1080P (360 Degree)

- 1. Wide Area coverage from a single camera
- 2. 4 x4MP multidirectional camera heads that cover 360-degree coverage
- 3. Each camera heads supports three streams
- 4. PoE+
- 5. Provide compatible ceiling mount bracket.
- 6. Acceptable product:
 - a. Tyco IFS16-M10-BT03 Illustra with dome and mounting bracket and hardware
 - b. Or approved equal

2.5 NETWORK DEVICES

A. Server configured with Video Management Software: VMS

- 1. Provides live monitoring and camera controls
- 2. Integrate with access control systems (ACS)

3. Audio and video playback and recording
4. 64-bit architecture
5. Simple and easy to use
6. Legacy camera support
7. Apps for apple and android devices.
8. Web interface
9. Multi setup and layouts based on access permissions.
10. Acceptable product:

- a. Panasonic / Video Insight VI-VMS-Dell R330 Monitor 6 and configuration.
- b. Or approved equal

B. Network switch(s)

1. 24 Port Gigabit Network Switch
2. Optimized for H.264 / H.265 unicast and multicast streams.
3. Ethernet AVB support: 802.1ak - Multiple Registration Protocol (MRP/ MMRP). 802.1AS - Timing and Synchronization for Time Sensitive Applications in Bridged Local Area Networks (PTP). 802.1Qat - Stream Reservation Protocol (SRP) 9 802.1Qav - Forwarding and Queuing Enhancements for Time-Sensitive Streams. 802.1AB-REV - Station and Media Access Control Connectivity Discovery (LLDP)
4. 2 Gigabit Interface Converter (GBIC) slots for optional fiber connectivity
5. Smart Control Center utility program automatically discovers devices
6. Administrative management via web-browser interface: Port configuration. Port monitoring. Port trunking. VLAN support. Class of Service (CoS). Layer 2 management. MAC address Filter. Ethertype Filtering Plug-and-play networking
7. Configured with PoE
8. Two SFP slots with fiber modules, provide fiber connectivity between AV network switches to allow for high bandwidth to support audio and streaming video connectivity.
9. Configured with V-lan to support control, AVB, and Streaming network traffic
10. Acceptable product:

- a. Cisco SG300-52MP
- b. NETGEAR GS724T Switch
- c. Or approved equal

C. H.264 / H.265 video server and storage array.

1. Scalable design and configuration
2. Supports advanced camera features
3. Provides IP Load balancing
4. All settings are stored database
5. Uses IIS for web access
6. SQL server based
7. Supports cameras up to 20 MP resolution
8. Automated failover functions
9. Processes unattended rules and alarms
10. Users' login to any server, no single point of failure
11. Supports 3,000 cameras from over 100 manufacturers
12. Supports camera- and server-side motion detection
13. Support for all storage
14. AD/LDAP active authentication

15. Designed for multi-server, multi-location, large camera deployments
16. Server shall be optimized for H.264 / H.265 unicast and multicast streams in either 720P or 1080P resolutions.
17. Drive Bays Up to sixteen 3.5" drives, two 2.5" drives
18. Chipset Intel® C610
19. Graphics Card 2D Matrox® G200 Integrated
20. I/O Slots 6x PCIe slots
21. Operating System Windows 2008 Server (WinSer 2012 upon request)
22. Optical Drive DVD+/-RW
23. Power Supply Dual, Hot-plug, Redundant Power Supply, 750W
24. Processor 2 x Intel® Xeon® Processor E5-2603 v3 1.6 HGZ, 15M Cache
25. RAM 8 GB
26. RAID Configuration OS (2, 500GB drives RAID 1), Storage configured in RAID 5 or RAID 6 (for 14 or more drives)
27. RAID Controller Perc H730 Integrated RAID Controller
28. Total Storage 96 TB
29. Network Controller Broadcom 5720 QP 1GB Network Daughter Card
30. Memory Up to 765GB (24 DIMM slots) 4GB/8GB/16GB/32GB DDR4 up to 2133MT/s
31. Cloud storage of camera and access information for up to 6 months.
32. Acceptable product:
 - a. Panasonic NVR-R-2-2-96TB
 - b. Or approved equal

2.6 PLATES AND PANELS

- A. Provide plates and panels as described in the drawings and as required for a fully operable system.
- B. Custom plated shall be 1/8" thick aluminum, standard EIA sizes, brushed black anodized finished unless otherwise noted.
- C. Plastic plates are not allowed.
- D. Lettering shall be in all caps and numbers engraved with a color contrasting to the base material with a minimum size of 0.25".
 1. Font Size shall be 1/8"
 - a. Font Style shall be Helvetica
- E. Acceptable manufacturers of custom plates and panels:
 1. RCI Custom
 2. Panel Authority
 3. Whirlwind

2.7 PROPOSED SUBSTITUTIONS

- A. Where specific equipment is described, it is not the intention to discriminate against the products

of other manufacturers, but rather to establish a standard of quality. All proposed substitutions should be submitted as alternates with exemption documentation for Consultant approval and complete product data sheets.

- B. The Owner's Representative and or Consultant requires manufacturer's original specification tests. The Owner's Representative and or Consultant will evaluate and approve/disapprove all substitutions.
- C. Items designated "no substitutions" shall be that specified item only. Submission of items other than specified shall not be considered and may disqualify RFP submission.

2.8 CABLES AND WIRING

- A. Shielded cables located in raceways shall have aluminum foil shield with drain wire.
- B. Plenum Rated / Non-Plenum Ratings: Cable routed in conduits and or equipment racks can have non-plenum rated (PVC) jacket. All other cables shall have a plenum or riser rated jacket compliant to the cable run and purpose. Cable runs shall be continuous without splices.
- C. Cable Selection: Based on signal type as indicated on single line diagram, noted at equipment input, or output connection type. Wire manufacturer and part numbers are provided as a basis of cable quality and signal characteristics. Alternate cable manufacturers to be requested for approval during pre-build submittal.
- D. Provide cabling compliant with Section 28 05 13 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY
- E. Provide the following cabling types as required by equipment manufacturers guidelines for a fully operable system:
 - 1. Communication outlet cables: 18 AWG 2 conductor shielded – West Penn 293
 - 2. Control cables: 18 AWG 2 conductor shielded – West Penn 293
 - 3. Antenna / CATV cable: RG-6 Quad Shield minimum refer to FCC / Cable provider recommendations as required.
 - 4. Precision video cable: Belden 8281 as required.
 - 5. Trunk video cable (RG6): West Penn Wire 841 (S).
 - 6. Trunk video cable (RG11): West Penn Wire 821.
 - 7. Video drop cable (RG6 Plenum): West Penn Wire 25841.
 - 8. Trunk video cable (RG11 Plenum): West Penn Wire 25821.
 - 9. 9-conductor 22AWG. Communications cable: Belden 9945.
 - 10. 9-conductor 18AWG. Communications cable: Belden 83659.
 - 11. Unshielded Twisted pair Category 5e Cabling West Penn Wire 254245
 - 12. F/UTP Category 6 Cabling West Penn Wire 254246AF
 - 13. Shielded Twisted pair HDBaseT Cabling Extron XTP DTP 24

PART 3 EXECUTION

3.1 INSTALLATION

- A. All equipment shall be mounted with sufficient clearance to meet all applicable codes and facilitate observation and testing.
- B. All equipment shall be securely fastened with appropriate fittings to ensure positive grounding and be free of ground loops throughout the entire system.
- C. Units shall be installed parallel and square to building lines. All wires shall be gathered and fastened to create an orderly installation.
- D. Electronic equipment shall be permanently mounted in equipment racks or as applicable to the equipment and application.
- E. Contractor shall mount all equipment, mounting brackets, plates, and panels, plumb and level.
- F. Contractor shall follow all applicable standards including ASIS Commission on Standards and Guidelines documentation as a basis of design, fabrication, construction, and Performance Verification.
- G. Contractor shall provide shaft locks or security covers on non-user operated equipment having front panel access.
- H. Contractor shall permanently install all equipment to be firmly mounted and held in place. Provide necessary equipment supports to hold and support loads with at least a 5:1 safety factor.
- I. Contractor shall validate bracing or blocking for proper mounting and safety.
- J. Contractor shall provide seismic bracing for appropriate equipment where the project is in a seismic zone, or it is required by local codes and or installation practices.

3.2 EQUIPMENT HOUSING

- A. Equipment Enclosures / Racks:
 - 1. Install all applicable equipment in racks and or wall mounts according to manufacturer's recommendations and product application.
 - 2. Provide adequate ventilation, thermal management, and temperature-controlled fans to maintain a rack temperature of less than 85 degrees Fahrenheit.
 - 3. Provide rear support and rear rack rails for housing mounted equipment greater than 15" deep.
 - 4. Allow a minimum of 20% open rack space to support future expansion...
 - 5. Fill all empty spaces with blank panels, sizing as required; painted and or anodized to match housing.
 - 6. Locate operator useable equipment and patch panels at an appropriate operating height.
 - 7. Key all door locks for each housing type (front, rear) alike.
 - 8. Looking at the equipment racks from the rear of the racks, install all AC power and ground cabling on the left and audio and video cabling on the right.
 - 9. Provide LED lights mounted in the top of every two racks to illuminate the interior for service or maintenance. LED lights shall be individually switch-able and placed so as to provide maximum illumination throughout the rack.
 - 10. Dress all loose cabling for a clean and orderly rack. The use of electrical tape for cable management is prohibited.

11. The use of tie wraps for network UTP, STP, and optical fiber cabling is prohibited.
12. Provide nylon braded sleeving for wiring harnesses for a clean installation of cabling that is visible to user areas. Sleeving color shall be coordinated with location and device color.

3.3 PATCH PANELS

A. Video Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Locate inputs from microphone input plates and floor plates on the top row of each patch bay.
4. Locate sends and tie-lines on the bottom row of each patch bay.
5. Coordinate final patch bay normaling as directed by the Owner's Representative and or Consultant.
6. Provide 24"x32" reference diagram of the patch bay system. The layout shall be easily understood. Mount diagram behind Plexiglas and mount in the rack or control room close to the patch bay rack.
7. Diagram shall show all input and output locations, patch normals, and any console connections and interconnection of rooms and equipment.

B. Unshielded Twisted Pair UTP / STP RJ-45 Patch Panel Configuration:

1. Patch panel shall be located in designated racks as shown on drawings.
2. All patch panels shall be in consecutive rack spaces located approximately 46" above the floor.
3. Configure and terminate patch bay per TIA / EIA standards.

3.4 LABELING

A. Device Labeling:

1. Provide, for each piece of rack-mounted equipment, a printed label (black background and white lettering) and attach to the front of the equipment. Install in a plumb, level, and permanent manner. Provide rear mounted labeling for all rack-mounted equipment.
2. Provide engraved label on each user-operated control that describes the function or purpose of the control as appropriate. Adjust size of label to appropriate size for location.

B. Rack Labeling:

1. Provide custom project plates at the top of each equipment rack designating Consultant and installation Contractor (see rack elevations for details).
2. All rack panel labeling shall be engraved and filled.

C. Wire and terminal strip labeling:

1. Provide each terminal strip with a unique descriptor and numerical designator for each strip. Show strip information on the drawings.
2. Provide logical and legible cable and wiring labels permanently attached for easy

- identification to each cable on both ends.
3. Label on cables shall be adhesive style striping covered with clear, heat shrink tubing, sized appropriately for the cable.
 4. Wiring designator shall be alphanumeric code, unique for each cable.
 5. Each cable type shall be labeled starting with different destinations (i.e. Camera series "Cxxx", / Low voltage Power series "LPxxx", etc.).
 6. On projects that have multi room connectivity the source and destination room numbers should be a part of the cable number indicating a cable that traverses between two rooms.
 7. Locate the cable designator at the origination and the destination of each circuit. Locate cable designator within 2" of connection point.

3.5 PERFORMANCE STANDARDS

- A. All provided devices / equipment shall meet and or exceed published manufacturer's specifications and be compliant with the outlined salient capabilities as described in section 2, and be compatible with all applicable standards and configurations

3.6 CONTRACTOR TESTING AND OR COMMISSIONING

- A. Prior to energizing or testing the system, ensure the following:
 1. All products are installed in a proper and safe manner per the manufacturer's instructions.
 2. Insulation and shrink tubing are present where required.
 3. Dust, debris, solder, splatter, etc. is removed.
 4. Cables are dressed, routed, and labels and all connections are consistent with regard to polarity.
 5. All labeling has been provided and installed.
 6. All products are neat, clean, unmarred and securely fastened.
 7. All debris has been cleaned and removed from the site.
 8. All electronic devices are properly grounded.
- B. Perform the following test. Record all results in the final project manual.
 1. Test each AC power outlet for proper connections for hot, neutral, and ground.
 2. Measure and record the DC resistance for the supplemental ground in the equipment rooms. Resistance should be 0.15 ohms or less.
- C. Input Verification Test: (Composite video)
 1. Verify video signal presence at each component input with test equipment and verify the proper signal and uniform strength.
 - a. Composite video shall conform to all applicable NTSC standards.
 2. Perform complete system operation to verify proper system operation.
 3. In a similar manner, check any other inputs or tie-lines as appropriate.
- D. Input Verification Test: (IP Cameras)
 1. Verify video stream presence on network and verify resolution and color depth settings.

2. Configure IP address for each stream to multi-image processor and to recorder as specified.
 - a. IP video shall conform to all applicable streaming media standards.
3. Perform complete system operation to verify proper system operation.
4. In a similar manner, check any other cameras or streaming devices as appropriate.

E. Notification:

1. Once all of the above is complete, the system is ready for inspection. Formally notify the Owner's representative and or consultant at least seven (7) days prior to desired inspection date.
2. Final adjustments and configurations will be conducted at the time of inspection.

3.7 CONSULTANT ACCEPTANCE TESTS

- A. Consultant acceptance tests will not be performed until after the contractor's system checkout as outlined within section 3.6 has been completed and the test results have been received and reviewed by the consultant and or owner's representative.
- B. Consultant acceptance testing will be conducted based on applicable sections of the ANSI/INFOCOM 10:2013 Audiovisual Systems Performance Verification Standard.
- C. Checklist items within this list will be verified by visual and or audible methods as part of normal use case operational scenarios, with the assumption that the contractor has fulfilled their obligation to test and ensure that the systems are tested, complete and free of operational defects per section 3.6 above.
- D. The system acceptance tests will be supervised by the consultant and will consist of the verification checklist as well as any additional tests as required:
 1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
 2. The operation of all system equipment shall be demonstrated by the contractor.
 3. Contractor shall provide a laptop to support testing activities that is configured and connected to any and all control processors for any evaluation and adjustments (tuning) activities by the consultant.
 4. Both subjective and objective operational tests will be required by the Consultant to determine compliance with the specifications and industry standards. The Contractor shall be responsible for providing all required test equipment based on system complexity and equipment selection / configuration.
 5. Operational use case test scenarios may be conducted based on programmed room uses and functionality.
 6. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Part I, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to the scheduling of Acceptance Tests).
 7. 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 consultant.

- E. Any charge for additional time incurred by the consultant required for overseeing the system tests, due to improper system installation or previous failed systems, shall be the responsibility of, and charged directly to the contractor and or subcontractor as appropriate.

END OF SECTION 28 23 00

SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. The installation of the following fire alarm devices for connection to the existing Edwards Systems Technology EST-3 fire alarm control panel located in the electrical room in the basement.
 - a. Manual fire-alarm boxes.
 - b. System smoke detectors.
 - c. Duct smoke detectors.
 - d. Notification appliances.
 - e. Addressable interface devices.
 - f. Sprinkler system flow alarm and valve position switches.
 - g. Connection to the new waste destruction suppression system.

1.2 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.3 SYSTEM DESCRIPTION

- A. Existing noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
- B. The installation of new fire alarm devices will be limited to the areas of the building under renovation.
- C. The new fire alarm devices shall be connected to the existing fire alarm system.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. General Submittal Requirements:
1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. NICET-certified fire-alarm technician, Level IV minimum.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - 2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
 - 3. Record copy of site-specific software.
- B. Software and Firmware Operational Documentation:
 - 1. Program Software Backup: On magnetic media or compact disk, complete with data files.
 - 2. Device address list.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm devices from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of the existing fire alarm system.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 - 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Notifier.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. One or more of the following new devices and systems in the building shall initiate a fire alarm signal:
1. Manual stations.
 2. Smoke detectors.
 3. Duct smoke detectors.
 4. Automatic sprinkler system water flow.
 5. Waste destruction fire suppression system activation.
- B. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Operation of fire protection system valve tamper switches.
- C. Existing Fire-alarm signal initiates the following actions:
1. Continuously operate alarm notification appliances.
 2. Identify alarm at fire-alarm control unit and existing remote annunciator.
 3. Transmit an alarm signal to the remote alarm receiving station.
 4. Shut down associated HVAC units.
 5. Release preaction system valve(s).
 6. Record events in the system memory.
- D. Modify existing fire-alarm system to initiate the following additional actions upon fire-alarm signal from associated initiating device:
1. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
 2. Close smoke dampers in air ducts of designated air-conditioning duct systems.
 3. Release coiling fire doors.

2.3 EXISTING FIRE-ALARM CONTROL UNIT: Edwards Systems Technologies EST-3.

- A. The existing EST-3 fire alarm control panel, located in the basement electrical room shall remain. Modify fire alarm control panel to accommodate additional fire alarm devices.

2.4 MANUAL PULL STATIONS.

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal,

- alarm, or trouble) to fire-alarm control unit.
- 2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors.

B. Duct Smoke Detectors

- 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
- 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
- 3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
- 4. Each sensor shall have multiple levels of detection sensitivity.
- 5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- 6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 ADDRESSABLE INTERFACE MODULES:

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuit, equipped for mounting as indicated and with screw terminals for system connections.

- 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Tone Notification Appliances:

- 1. Comply with UL 1480.
- 2. Mounting: Semi-recessed in finished areas; surface mounted in spaces without finished walls and ceilings.
- 3. Matching Transformers: Tap range matched to acoustical environment of speaker location.

- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
1. Mounting: Wall mounted unless otherwise indicated.
 2. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 3. Flashing shall be in a temporal pattern, synchronized with other units.
 4. Strobe Leads: Factory connected to screw terminals.
 5. Mounting Faceplate: Factory finished, white.

2.8 COILING FIRE DOOR RELEASE DEVICES

- A. Description: Units are furnished under Division 08, Door Hardware. Make connections to fire alarm system.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, IBC, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.
1. Connect new equipment to existing control panel in existing part of the building.
 2. Expand, modify, and supplement existing control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
- C. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

3.2 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.3 FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.
- B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."
 - 1. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 2. Signaling Line Circuits: Power-limited fire-alarm cables must not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

3.4 PATHWAYS

- A. Pathways above recessed ceilings and in non-accessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.
- B. Pathways shall be installed in EMT.
- C. Exposed EMT shall be painted red enamel.

3.5 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connection to waste destruction suppression system.
 - 2. Smoke dampers in air ducts of designated HVAC duct systems.
 - 3. Electronically locked doors and access gates.

3.6 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Architect and Engineer.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Prepare for final test and commissioning. Ensure all components of the project's fire protection systems are inspected and pre-tested prior to requesting a final inspection, test and commissioning. Inspection deficiencies will be referenced to NFPA requirements, and Contract Specification requirements. Use, as a minimum, the following pre-commissioning check list:
 - a. NFPA 72" Fire Alarm System Record of Completion" form completed by contractor.
 - b. System meets contract specification requirements
 - c. System has been inspected and pre-tested
 - d. Proper batteries installed
 - e. System is free of all trouble conditions
 - f. System has been programmed to meet specification requirements
 - g. Systems device text programming has been coordinated with the Park to ensure proper device identity and location.
 - h. All devices and components installed per approved shop drawings
 - i. All devices properly labeled and properly identified on as-builts
 - j. All conduit box covers in place
 - k. No T-Tap connections or splices in circuits
 - l. No flexible conduit exceeds 6 feet in length
 - m. All control relays located within 3 feet of controlled equipment
 - n. All required surge suppressors properly installed (including required suppressors for F/A circuits leaving and entering buildings)
 - o. Elevator recall functions per code and contract documents
 - 2. Visual Inspection: Conduct visual inspection prior to testing.

- a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 3. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 4. Prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 28 31 11