

SPECIFICATIONS

PROJECT NO. DGS C-0948-0098 Phase 001

**Contract No. DGS C-0948-0098 Phase 1.2-HVAC Construction
Contract No. DGS C-0948-0098 Phase 1.3-Plumbing Construction
Contract No. DGS C-0948-0098 Phase 1.4-Electrical Construction**

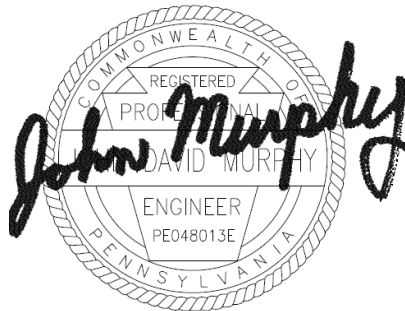
For

Automation Systems Upgrade

**Capitol Complex
Harrisburg, Pennsylvania**

**COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA**

**Governor Josh Shapiro
Reginald B. McNeil, II, Secretary**



Date: February 14, 2024

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MECHANICAL CONSTRUCTION

CONTRACT NO. DGS C-0948-0098 PHASE 1.3

MECHANICAL DRAWINGS:

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CONTRACT NO. DGS C-0948-0098 PHASE 1.3

PLUMBING DRAWINGS:

P-0	PLUMBING LEGEND, NOTES & ABBREVIATIONS
P-1	PLUMBING SITE PLAN
P-2	LABOR & INDUSTRY BUILDING PLUMBING PLAN
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P-10	MAIN CAPITOL CENTER SUB BASEMENT PLUMBING PLAN
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CONTRACT NO. DGS C-0948-0098 PHASE 1.4

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E-14 PA STATE MUSEUM ELECTRICAL PLAN
E-15 ELECTRICAL DETAILS

END OF SECTION

SECTION 010100 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 LOCATION

- A. The Capitol Complex, Harrisburg PA

1.03 PROJECT DESCRIPTION

- A. Utility meters will be installed at the locations of entry of a facility for the following utilities: Domestic Water, Natural Gas, Chilled Water & Steam. The facilities in scope include Labor & Industry, Health & Welfare, Keystone, PA Judicial Center, North Office, East Wing, Main Capitol, K. Leroy Irvis, and Matthew J Ryan, Finance, Forum, PA State Museum & Central Utility Plant. Some of these facilities have multiple connections or inlets to a single utility and may require multiple meters. These meters will be integrated to the Building Automation System within each respective facility. The existing electric metering system will be interfaced with the building automation systems virtually.
- B. New telecommunications infrastructure will be provided to the Ryan Building, Main Capitol North dome, Main Capitol center dome and Main Capitol south dome. The infrastructure includes data racks, fiber optic patch panels, fiber optic cabling, cable management, terminations, testing, and rack mount UPS systems. 120v circuits will be provided for new data racks.

1.04 CONTRACT DURATION

- A. The Construction Contract duration shall be **392** calendar days commencing on the date of the Initial Job Conference.
- B. Refer to Section 013100 for how the contract duration may be impacted by long lead-time materials and equipment.

1.05 WORK INCLUDED

- A. The Work of this Project consists of, but is not necessarily limited to, the following. Detailed requirements of the Work are described in the pertinent specification Sections and/or shown on the Drawings.
- B. HVAC Construction (.2) Contract:
 - 1. Steam metering and associated piping, valves and connections.

2. Chilled water metering and associated piping, valves and connections.
3. Building automation controls, equipment, programming, conduit and wiring to integrate the proposed steam, chilled water, domestic water natural gas and electric metering into the existing BAS systems.

C. Plumbing Construction (.3) Contract:

1. Domestic water metering and associated piping, valves and connections.
2. Natural gas metering and associated piping, valves and connections.

D. Electrical Construction (.4) Contract:

1. Integrate existing Schneider Electric Power logic metering system into existing Automatic Logic and Johnson Controls Building Automation System by making metering points on existing virtual server readable by the BAS systems (map points).
2. Telecommunications system infrastructure.
3. Power for metering systems and building automation systems control

1.06 SPECIFICATION FORMAT

- A. The Specifications for the work of the separate prime Contracts are bound in one volume. Technical provisions which apply to each prime Contract are included in the Divisions listed below:
- B. HVAC Construction (.2) Contract: Divisions 01, 23 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25,.
- C. Plumbing Construction (.3) Contract: Divisions 01, 22 and applicable Sections of Divisions 02, 03, 05, 07, 09, 25,
- D. Electrical Construction (.4) Contract: Divisions 01, 25, 26 and applicable Sections of 02, 03, 07, 08,.

1.07 E-BUILDER CONSTRUCTION MANAGEMENT SOFTWARE

- A. The electronic document repository to improve productivity and efficiency, and to streamline the process of construction management during all phases of design, procurement, award and contract administration. The Department and all Prime Contractors will utilize the e-Builder Enterprise Software Program (e-Builder) for all Work and administrative duties provided under this Contract. Any and all notifications, request, submittals, approvals, etc. between the Department, The Prime Contractors, the Professional, and/or the Construction Manager (if a CM is assigned to the Project) shall be through the e-Builder system.

1.08 QUESTIONS DURING BIDDING PERIOD

- A. Direct all questions pertaining to the Project to the Project Professional utilizing the e-Builder Enterprise Software Program (e-Builder) as described in the Instructions To Bidders.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 010300 - BASE BID DESCRIPTIONS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SECTION INCLUDES

- A. This Section includes identification of each Base Bid and description of the changes to be associated with each Base Bid.

1.03 DESCRIPTION OF SEPARATE BASE BIDS

A. HVAC CONSTRUCTION CONTRACT (DGS C-0948-0098PHASE 1.2)

1. Base Bid No. 1:

- a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid. This includes but is not limited to:
- b. Telecommunications wiring infrastructure.
- c. Chilled water system metering.
- d. Steam Metering.

2. Base Bid No. 2:

- a. Same as Base Bid No. 1, except add - - -the following"
- b. Interface of existing electric meter server with ALC and JCI BAS Systems.

3. Base Bid No. 3:

- a. Same as Base Bid No. 2, except add - - -the following:
- b. Domestic water metering.

4. Base Bid No. 4:

- a. Same as Base Bid No. 3, except add the following:
- b. Gas metering.

B. PLUMBING CONSTRUCTION CONTRACT (DGS C-0948-0098PHASE -1.3)

1. Base Bid No. 1:

- a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid. This includes but is not limited to:
 - b. Telecommunications wiring infrastructure.
 - c. Chilled water system metering.
 - d. Steam Metering.
 - 2. Base Bid No. 2:
 - a. Same as Base Bid No. 1, except add - - -the following"
 - b. Interface of existing electric meter server with ALC and JCI BAS Systems.
 - 3. Base Bid No. 3:
 - a. Same as Base Bid No. 2, except add - - -the following:
 - b. Domestic water metering.
 - 4. Base Bid No. 4:
 - a. Same as Base Bid No. 3, except add the following:
 - b. Gas metering.
- C. ELECTRICAL CONSTRUCTION CONTRACT (DGS C-0948-0098 PHASE1.4)
- 1. Base Bid No. 1:
 - a. Shall include all the work indicated on the Contract Drawings and described in the Contract Specifications except that work specifically called out as being part of another Base Bid. This includes but is not limited to:
 - b. Telecommunications wiring infrastructure.
 - c. Chilled water system metering.
 - d. Steam Metering.
 - 2. Base Bid No. 2:
 - a. Same as Base Bid No. 1, except add - - -the following"
 - b. Interface of existing electric meter server with ALC and JCI BAS Systems.
 - 3. Base Bid No. 3:
 - a. Same as Base Bid No. 2, except add - - -the following:
 - b. Domestic water metering.
 - 4. Base Bid No. 4:
 - a. Same as Base Bid No. 3, except add the following:
 - b. Gas metering.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 010400 - COORDINATION AND CONTROL

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SECTION INCLUDES

- A. This section includes the on-site provisions that govern the performance of the work to complete this Project.

1.03 CONTRACTS - FOR THIS PROJECT CONSTRUCTION

- A. DGS C-0948-0098PHASE1.2 HVAC Construction (Lead Contractor)
- B. DGS C-0948-0098PHASE1.3 Plumbing Construction
- C. DGS C-0948-0098PHASE1.4 Electrical Construction

1.04 VISIT TO SITE

- A. For access to the site during the bidding period contact the Client Agency site personnel with phone number listed below:
 - 1. Client Agency Site Representative: Corey Lex
 - 2. Telephone Number: (717) 695-1702

1.05 UNIDENTIFIED HAZARDOUS MATERIALS (ASBESTOS, CHEMICALS, ETC.)

- A. There is a possibility that hazardous materials not identified in the contract documents may be discovered on this project. Should it be determined that some or all of the hazardous materials must be removed, the Contractor shall obtain an estimate for said removal from a Subcontractor who is experienced in the field, has insurance and is knowledgeable of the regulations as they apply. The Contractor may provide the estimate itself if it is qualified in the applicable hazardous materials field. The Department shall consider authorizing a Change Order for the removal of the hazardous material to the extent necessary.
- B. The Contractor or Subcontractor must comply with all requirements of the General Conditions, including the maintenance of insurance up to the limit required under the General Conditions.
- C. Should a hazardous material be encountered on the job, the Contractor shall comply with all statutes and regulations of the Commonwealth of Pennsylvania and all rules and regulations of the United States Environmental Protection Agency as they apply during construction and demolition work and the disposal of hazardous material. Particular attention is drawn to Code

of Federal Regulations, Title 40, Part 61, Section 112 of Clean Air Act and PA Department of Labor and Industry, Act 194 for asbestos.

- D. The Contractor shall comply fully with the regulations of OSHA as they pertain to the protection of workers exposed to the emission of asbestos fibers, chemicals, etc. and shall take all steps necessary to protect its employees, as well as all other people occupying the building.
- E. Whenever a hazardous material is to be removed or disposed of, the Contractor is required to make proper notification to the Bureau of Air Quality in the PA Department of Environmental Protections' Regional Office, PA Department of Labor and Industry and EPA as applicable, and is required to obtain and pay for any permits required. Disposal shall conform to all applicable regulations and documentation shall be required when, applicable.

1.06 LEAD PAINT

- A. All work is to be performed with the assumption that all painted surfaces are lead containing. Each Prime Contractor is responsible for following all required OSHA 1926.62 'Lead In Construction' standards when disturbing or impacting these painted surfaces during the course of the renovations, including but not limited to activities such as: cutting and patching, core drilling, penetration, anchoring, fastening, etc. The area(s) shall be visually clean upon completion of any of these activities.
 - 1. Action Plan: Contractor(s) shall submit an Action Plan that conforms to Paragraph 1.6.A.1-3 herein for approval at the Initial Job Conference, which specifically outlines details of means and methods to be used for each dust-generating activity involving lead-painted surfaces, erection of critical barriers and plastic sheeting for dust control, subsequent exposure assessment, personal protective equipment, hygiene and clean-up.
 - 2. Contractor(s) shall utilize means and methods that preclude dust generation to complete work that disturbs/impacts lead-containing paint (i.e., paint stripper, HEPA-assisted drills, etc.).
 - 3. Contractor(s) shall ensure areas beyond work area are not contaminated, and shall immediately stop work and erect plastic sheeting to prevent the spread of dust, anytime means and methods inadvertently create dust.

1.07 MOLD

- A. In the event mold is encountered, the Contractor shall implement corrective actions to protect workers, other building occupants, and to prevent the disturbance of mold in affected areas. Although not presently regulated by EPA and/or OSHA, the EPA does provide industry standards regarding worker safety and abatement procedures, which are the minimum procedures to be followed if mold is encountered.
- B. Any mold that appears as a result of construction shall be abated immediately by the Contractor responsible for this condition. The affected surface shall be cleaned, removed, and replaced. Inspection and testing shall be done by a qualified testing agency to confirm the mold has been removed in its entirety.

1.08 TESTING OF EQUIPMENT

- A. After any equipment furnished under the contract and any permanent heating, ventilating, plumbing, drainage or electrical systems and equipment have been installed or modified, it shall be the responsibility of the Contractor to operate its equipment for a satisfactory period of time,

as required by the Department for proper testing and instructing the operating personnel. Fuel, electricity and water required for proper testing of permanent equipment and for the period of instructing personnel, shall be paid for by the Contractor testing its equipment.

1.09 INSTRUCTIONS AND TRAINING

- A. Refer to the General Conditions of the Construction Contract, as specified in the applicable technical portion of each specification for "Operations and Maintenance Instruction Manuals" and "Record Drawings" requirements.
- B. Unless approved by the Department, training shall not be scheduled/conducted until Record Drawings, Operation and Maintenance Instruction Manuals, valve tag lists, equipment and piping system identification, and all software programming is complete.
- C. Provide full on-site training and instruction to designated Commonwealth personnel given by competent manufacturer's authorized personnel thoroughly familiar with all technical and operational aspects of the installed items. Instructions are to cover operation and maintenance of all systems, equipment components and other items as specified and furnished under this contract. Instructional digital video recordings may be used to augment required instructions and training but may not be substituted for the in person on-site training. All on-site training shall be digitally recorded by the Contractor. The digital video files are to be turned over to the Client Agency.
- D. Contractor shall provide an outline of the training and course content, which shall be submitted and accepted by the Professional and the Department prior to conducting training.
- E. Conduct instruction and training during regular working hours. For training on complicated systems, allow at least one-half of the training time to be at and/or with the system equipment.
- F. Provide additional training and instructions for all significant modifications and/or changes made under the terms and/or conditions of the manufacturer's and/or Contractor's warranty.
- G. The Contractor shall maintain and submit a sign-in list that clearly documents all personnel attending the training.

1.10 PROJECT SIGN

- A. Provide a Project Sign. Refer to the General Conditions of the Construction Contract.

1.11 REUSE OF MATERIALS

- A. No removed materials or equipment shall be reinstalled in the work, unless so noted on the Drawing or in these Specifications.

1.12 GENERAL

- A. All construction trailers, offices, equipment and materials required to be on-site shall be located as shown on the Drawings, or at the direction of the Department.

1.13 WORKING HOURS

- A. The Contractor's available working hours shall be from 7:00 A.M. to 5:00 P.M., Monday through Friday.
- B. Work during different hours, or work on Saturdays, Sundays, State and National Holidays or overtime work, must have the Regional Director's or his designee's prior written approval. Work on these days if approved shall be at no additional cost or time to the Contract.
- C. This shall not apply in those unforeseen isolated and/or emergency instances when a particular operation must be performed in a continuous sequence that extends the working day beyond the approved working hours. Coordinate with the Department in these instances.
- D. The Department's failure to approve different working hours, weekend or holiday working hours, or overtime hours is not cause for a claim against the Department for delay or any added costs or time to the Contract.
- E. Utility shut-downs required for tie-ins to existing systems shall be done in off-hours, weekends, and/or holidays to minimize the impact on the operations of the Client Agencies (and/ or surrounding buildings). These costs shall be anticipated and included in the Contractor's bid.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Prefinished materials shall arrive at job site in their original unopened cartons or other protective packaging necessary to protect finishes. Materials shall be stored in such packages until time of application. Flat materials such as panels shall arrive and remain on adequate support to ensure flatness and prevent damage.
- B. Store all materials, equipment and bulk items prior to installation in clean, dry, well ventilated locations away from uncured concrete, masonry or damage of any kind. Waterproof tarpaulin or polyethylene sheeting must allow for air circulation under covering.
- C. Coordinate storage location with the Department.
- D. Refer to each section for specific delivery, handling and storage instructions of items specified.

1.15 PARKING

- A. Parking is not available. Contractor shall make his own arrangements for parking. shall be limited to areas indicated on the Site Plans. All parking is subject to prior approval of the Department and Client Agency.

1.16 TRAFFIC PLAN

- A. The Lead Contractor shall submit in eBuilder prior to the Initial Job Conference a construction staging and traffic plan for the project which minimizes the construction interference with the Client Agency's operation. This plan is subject to the Department's and the Client Agency's review and acceptance. This acceptance does not relieve the Contractors of their responsibilities regarding safety coordination, and adherence to all traffic laws and ordinances.

1.17 ENVIRONMENTAL QUALITY CONTROL

- A. The Prime Contractor and its Subcontractors shall perform their work in a manner which shall minimize the possibility of air, water, land and noise pollution, in accordance with the General Conditions of the Construction Contract.
- B. The name, address and telephone number of the Department of Environmental Protection Regional Office is furnished below. This office shall be contacted for waste disposal permits and for information concerning sites already approved for conducting waste disposal.

Counties:

Southcentral Regional Office Counties:
909 Elmerton Avenue Dauphin, ,
Harrisburg, Pa. 17110-8200
(717) 705-4700

OFFICE FOR CONTRACTOR

- C. Each Prime Contractor shall provide and maintain, at its cost, a suitable office on the premises, at a location shown on the Lead Contractor's accepted staging plan. The Contractor shall provide and maintain heating facilities and supply fuel for same in cold weather, and shall remove the office from the premises at completion of all work. Provide electrical, telephone and internet service.

1.18 DGS CONSTRUCTION COORDINATOR OFFICE

- A. DGS Project Coordination will utilize meeting space and equipment within the Capitol Complex or the Arsenal building for job conferences and other project activities. No temporary field office (trailer) for the DGS Project Coordination will be required for the project.

- 1. No equipment is required to be provided for the use of the DGS Project Coordination team.

1.19 SANITARY FACILITIES

- A. The following conditions shall pertain:
 - 1. Sanitary facilities will, within the limitations of the existing facilities, be provided by the Client Agency at no cost. The Lead Contractor shall provide all supplies and maintain the facilities in a clean and sanitary manner at all times.
 - 2. The existing facilities available for the Contractor's use will be assigned by the Department at the Initial Job Conference.

1.20 SMOKING POLICY

- A. Smoking and use of smokeless-tobacco, chewing tobacco, snuff, Vape machines and similar paraphernalia are strictly prohibited in all buildings.

1.21 CONCRETE

- A. All Contractors shall perform concrete work and earthwork required for their work, and shall comply with applicable Division 2, 3, sections. If any specification section contains language conflicting with requirements of applicable Division 2, 3, 31, 32, and 33 sections, the most stringent requirements shall prevail.

1.22 QUALITY CONTROL TESTING

- A. Structural-related testing and inspections required to be performed by the Contractor(s) are listed in Section 014000 - Quality Control Testing Services. If Quality Control testing or inspections required appear in Section 014000 and in a technical section, the most stringent requirements shall prevail. If Quality Control testing or inspections required appear in a technical section and not in Section 014000, they shall be required as if specified in Section 014000. Conditions pertaining to Quality Control testing and inspections may appear in the technical sections. All testing herein is to be by the Contractor. Testing by the Department, Quality Assurance Testing, is for the purpose of checking the results of the Contractor's Quality Control Testing. Testing is to be by the Contractor, unless specifically stated to be "by the Department" or required by Section 014010 - Quality Assurance Testing and Inspection Services.
- B. Non-structural testing is in the technical specifications.

1.23 CADD FILE WAIVER

- A. The Professional will make graphic portions of the bid drawings available for use by the Contractor by uploading files to e-Builder.
- B. Electronic files shall be uploaded only after all construction contracts have been executed.
- C. The files are provided as a convenience to the Contractor, for use in preparing shop drawings and/or coordination drawings related to the construction of this Project only. These files and the information contained within are the property of the Department, and may not be reproduced or used in any format except in conjunction with this Project.
- D. The Contractor acknowledges that the information provided in these files is not a substitution or replacement for the Contract Documents and does not become a Contract Document. The Contractor acknowledges that neither the Professional nor the Department warrant or make any representation that the information contained in these files reflect the Contract Documents in their entirety. The Contractor assumes full responsibility in the use of these files and acknowledges that all addenda, clarifications and changes to the drawings executed as a part of the Contract Documents may or may not be incorporated in these electronic files.
- E. The Contractor acknowledges that the furnishing of these files in no way relieves the Contractor from the responsibility for the preparation of shop drawings or other schedules as set forth in the Contract between the Contractor and the Department.
- F. The electronic documents shall be stripped of the Professional's name and address, and any professional licenses and signatures indicated on the contract documents. Use of these electronic documents is solely at the Contractor's risk, and shall in no way alter the Contractor's Contract for Construction.
- G. Disclaimer: The Professional and Department make no representation regarding fitness for any

particular purpose, or suitability for use with any software or hardware, and shall not be responsible or liable for errors, defects, inexactitudes, or anomalies in the data, information, or documents (including drawings and specifications) caused by the Professional's or its Consultant's computer software or hardware defects or errors; the Professional's or its Consultant's electronic or disk transmittal of data, information or documents; or the Professional's or its Consultant's reformatting or automated conversion of data, information or documents electronically or disk transmitted from the Professional's Consultants to the Professional.

- H. By the Contractor's or their subcontractor's use of the electronic files (e.g., AutoCAD files), the Contractor and their subcontractor waive all claims against the Department the Professional, its employees, officers and Consultants for any and all damages, losses, or expenses the Contractor incurs from any defects or errors in the electronic documents. Furthermore, the Contractor shall indemnify, defend, and hold harmless the Department, the Professional, and its Consultants together with their respective employees and officers, from and against any claims, suits, demands, causes of action, losses, damages or expenses (including all attorney's fees and litigation expenses) attributed to errors or defects in data, information or documents, including drawings and specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 013100 - SEQUENCE OF CONSTRUCTION AND MILESTONES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 GENERAL REQUIREMENTS

- A. Before beginning work, the Contractor will be required to prepare a Critical Path Method (CPM) Project Schedule in consultation with the Department and all of the other Prime Contractors. The work must be carried out in full accordance with the schedule. The Contractor shall arrange to perform the work without any unnecessary interference with the Institution's operation.
- B. The Project Schedule shall be developed in conformance with Article 8 of the General Conditions of the Contract, except as modified and/or augmented by this Section.
- C. The detailed Project Schedule shall be developed in accordance with the Contract Documents, with the HVAC Contractor being the "Lead" Contractor. The Lead Contractor shall furnish each Prime Contractor a draft progress schedule of the proposed prosecution of the Work under that Contractor's Contract within seven (7) calendar days of the Effective Date of the Contract or the date directed in the Letter of Intent to Contract. All Prime Contractors must provide the required scheduling data for their work to the Lead Contractor within seven (7) calendar days of the receipt of the Lead Contractor's draft progress schedule to facilitate the development of the CPM schedule. The submission of the Project Schedule, and all subsequent updates, shall be done in eBuilder utilizing the scheduling software native file as well as in PDF format (including all requested sorts and arrangements, utilizing color print). The attachments in e-Builder shall include all unlocked data files in the scheduling system used to develop the schedule. The start date on the schedule shall be the Initial Job Conference and end with the Contract Completion Date. The final fully integrated and detailed Project Schedule, accepted by all Prime Contractors, must be submitted in eBuilder for Professional and Departmental acceptance within thirty (30) calendar days of the Effective Date of the Contract or the date directed in the Letter of Intent to Contract. Failure to submit an acceptable Project Schedule within that timeframe will result in liquidated damages of \$500.00 per calendar day assessed against each Prime Contractor until an accepted Project Schedule is received.
- D. The use of float suppression techniques, such as preferential sequencing (arranging the critical path through activities more susceptible to Client Agency or Department caused delays), special lead/lag logic restraints, zero total or free float constraints, extended activity times or imposing constraint dates other than as required by the contract, shall be cause for the rejection of the submitted project schedule or its updates. The use of Resource Leveling (or similar software features) used for the purpose of artificially adjusting activity durations to consume float and influence the critical path is expressly forbidden.
- E. Contractors shall also track submissions, ordering dates and delivery of materials in the Project

Schedule.

- F. A large sized copy of the accepted Project Schedule shall be maintained and posted in the DGS Construction Coordinators field office for access and monitoring of the progress of the work activities. At the direction of the Department, large sized copies of monthly schedule updates shall also be provided, posted and maintained in the DGS Construction Coordinators field office

1.03 CRITICAL MATERIALS AND EQUIPMENT

- A. The Contractor is cautioned that all necessary and required critical materials and equipment shall be ordered as quickly as possible, in order that the shipping will not delay the progress of the work or completion of the project.
- B. Listed Critical/long lead items in this section are not an all-inclusive list of required critical/long lead submittals. All Contractors are required to perform their own review of the documents and make submissions as necessary so as not to delay the project. The Contractor shall recognize and acknowledge that all critical materials and equipment shall be ordered immediately after receipt of approved shop drawings to ensure that lead time and shipping will not delay the progress of the work or completion of the project. Any costs necessary to expedite manufacturing and/or delivery of materials and equipment to maintain the project schedule shall be the responsibility of the contractor. No additional costs will be paid by the Department.

1.04 CRITICAL ITEMS TO BE NOTED AS MILESTONES

- A. Refer to the General Conditions, Article 8 'Project Schedule', regarding construction progress Milestones to be established by the Lead Contractor.
- B. Listed Critical/long lead items in this section are not an all-inclusive list of required critical/long lead submittals. All Contractors are required to perform their own review of the documents and make submissions as necessary so as not to delay the project. The Contractor shall recognize and acknowledge that all critical materials and equipment shall be ordered immediately after receipt of approved shop drawings to ensure that lead time and shipping will not delay the progress of the work or completion of the project. Any costs necessary to expedite manufacturing and/or delivery of materials and equipment to maintain the project schedule shall be the responsibility of the contractor. No additional costs will be paid by the Department.
- C. These prime contractor Milestones are not meant to be all inclusive for any contractor. It is each prime contractor's responsibility to understand the work required and to recognize and identify each critical Milestone and task required to complete the project on schedule. The Department reserves the right to add, delete and/or modify milestones at time of schedule review and acceptance or as necessary throughout the project.
- D. The milestones noted in this section of the specifications apply to all the Prime Contractors. The HVAC, Plumbing and Electrical Prime Contractors shall adhere to the milestones and incorporate their work activities into the Project Schedule in order to achieve the milestones for the project per the contract documents. (Example: wall rough in work must take place with the wall construction milestones, etc.).
- E. Time is of the essence for this contract.
 - 1. If the contractor fails to meet milestones such as but not limited to structural steel,

foundations, building enclosure per specification section 015000, punch list, testing, balancing (if required) including any necessary adjustments or corrections related to such tests, and commissioning.

2. Or fails to obtain L&I Certificate of Occupancy/Utilization on or before dates set forth in this section.
3. Or complete all the work including change orders, by the dates set forth in this section.

1.05 SEQUENCING OF CONSTRUCTION AND OTHER REQUIREMENTS

- A. The Department shall assess the contractor(s), as Liquidated Damages, not as a penalty for such failure, the sum stipulated within the bid documents per calendar day, until all milestones are met, and all work is completed and accepted by the Department. Liquidated Damages are also applicable and assessable for noncompliance with the dates listed in the accepted Project Schedule
- B. *When the Work of this Project includes longer than industry standard lead-times for materials or equipment for which all other tasks on the Project Schedule become dependent, the Department may issue a notice of a temporary suspension of the Work. If temporarily suspended, the Contractor must notify the Department at least thirty (30) days prior to the delivery date of the materials or equipment. Upon such notice, the Department will terminate the suspension and direct resumption of the Work to occur on or about the delivery date. The Contractor, in consultation with the Department, will evaluate the length of time needed to complete the project and a non-compensatory Extension of Time Change Order may be submitted by the Prime Contractor(s), which the Department will review in accordance with the Administrative Procedures governing Extensions of Time. During the temporary suspension, the Contractor will be responsible to maintain all installed temporary facilities.*

1.06 CONSTRUCTION PROGRAM

- A. Buildings shall be fully occupied during construction. All utility shut downs and associated work shall be performed off-hours and scheduled in advance with the client agency
- B. All work shall be sequenced for maximum continuity of service. Install all new work (piping, meters, valves, wiring, etc.) prior to intercept/cut-overs to existing utilities.
- C. All equipment and materials needed for shut-downs shall be on-site in advance of any utility shut-downs.
- D. Time is of the essence for this Contract. Each Prime Contractor and all their subcontractors (of any tier) shall employ a sufficient number of qualified employees, supervision/management, equipment and project resources, required to meet the milestones and completion date established for this Project. All activities shall be performed such that required completion dates (including completion of punch list and obtaining L&I Certificate of Occupancy/Utilization) are met as identified in this section. All Contractors are required to employ multiple crews with necessary manpower, equipment, materials, supervision/management etc. to perform the aforementioned work activities. Each Prime Contractor shall perform the Work on multiple shifts as necessary during each 24-hour day period to meet all milestones and complete the various portions of the project by the required completion dates identified in this section. The crew size of the off-shift work must be composed of a sufficient number of workers as required to support all other Prime Contractor's efforts to do the same. Proper supervision must be provided for all work activities. No work shall be covered or concealed during off-shift work activities in such a manner that it cannot be observed the morning of the next work shift. See paragraph 1.6.F of

this specification regarding the Pennsylvania Department of Labor and Industries (L&I) inspections.

- E. Pre-installation meetings are required for each electrical outage or interruption as well as installation or modification of all electrical equipment or systems. The pre-installation meetings shall be held the same dates as the regularly scheduled bi-weekly job conferences. Each Prime Contractor shall coordinate with the Department any preinstallation meeting scheduling requirements in order to avoid delays in the installation of any items or systems requiring a pre-installation meeting. Each Prime Contractor requiring a pre-installation meeting to comply with the contract documents, shall request the meeting a minimum of two weeks prior to the scheduled installation of the item or system. Failure to request a pre-installation meeting in the required time period will not relieve the contractors of their responsibility to comply with all contract documents including but not limited to the Project Schedule. No additional compensation or extension of time will be granted by the Department to the contractors for their failure to schedule or attend any of the required pre-installation meetings.
- F. Each Prime Contractor shall coordinate with the Department any scheduling requirements in order to avoid disruption of programs and activities, as well as to coordinate the location of the various structures to be constructed (i.e. temporary trailers, temporary construction fences, and temporary access corridors, temporary roadways, temporary doors and windows, temporary enclosures, temporary partitions, etc.) All work performed under this Project shall be done in a manner that will not disrupt normal activities in and around the facility.
- G. All Prime Contractors are expected to work outside of normal work hours as necessary, in shifts and on weekends to maintain the Project Schedule. All Prime Contractors are to comply with noise levels restrictions in accordance with facility operational requirements and all local ordinances. This may require exterior work to be completed during the day shift only.
- H. Each Prime Contractor shall coordinate and schedule inspections as required by the provisions of the Building Permit issued by Pennsylvania Department of Labor and Industry (L&I). The L&I Inspectors will only be available during the day shift. L&I Inspectors availability does not constitute a delay to the progress of the project and shall be considered by each Prime Contractor when scheduling and completing the work of this project.
- I. It is understood that during the duration of the Project, changes may be made to the Project Schedule without the Department incurring additional costs or granting extensions of time to the Contract.
- J. Change Orders shall occur on this project to address unforeseen conditions, errors and/or omissions in the documents and other potential conflicts. It shall be mandatory that each Prime Contractor (along with all its subcontractors of any tier) provides necessary additional work forces to accommodate these changes in a manner to eliminate any delays to milestones or the overall project schedule. The Department will issue no Extension of Time for performance of Change Order work; all time must be recovered in the affected work activities.
- K. The Department reserves the right to delay or suspend any work, without compensation due any of the Contractors, if the Department determines that any work would disrupt activities in or around the facility.
- L. In the event that:
 - 1. Prime Contractor(s) fails to achieve any interim milestones established for the building

program in accordance with the Contract Documents and the Project Schedule or

2. Any schedule update showing the work behind schedule and in jeopardy of meeting the accepted milestone dates,
3. The Department will notify the Prime Contractor(s) that they are in default of the contract. The defaulting Prime Contractor will be given three (3) calendar days to correct the deficiency. In the event the defaulting Prime Contractor fails to correct the deficiency within three (3) calendar days or fails to staff the job properly or work the required shifts/overtime/weekends necessary to maintain the schedule and achieve the milestones; in addition to liquidated damages the Department may take necessary actions to ensure the CPM Project Schedule is maintained. All costs and fees associated with such supplementation shall be deducted from the defaulting Prime Contractor's contract value.

- M. While time is of the essence, each Prime Contractor (as well as each of their subcontractors of any tier) shall not compromise the safety of any individuals while performing any of their work. Contractors shall take all the necessary precautions to maintain safety during the progress of the work including, but not limited to, fall protection, shoring, barricades, signage, safety tape and rails, temporary ramps, temporary roads, temporary partitions, fencing, etc.

1.07 FURTHER CLARIFICATIONS

- A. By submitting a bid, the Contractor acknowledges that the abbreviated list of milestones for construction work (as provided in this section) was provided for informational purposes, and to ensure all Prime Contractors understand the critical mandatory completions/durations necessary to accommodate the requirements and sequence of completion to meet the needs of the Client Agency. It constitutes a proposed sequence of events based on standard construction practices and will not form the basis for any claims for inefficiency, acceleration or delays. The coordinated Project Schedule will be developed in accordance with this section and the Contract Documents by the Prime Contractors and the actual milestone dates for the project will be agreed upon by all Prime Contractors based on the accepted schedule.
- B. If there is a conflict between what is stated in this Section and the General Conditions of the Contract, the contract specifications, the contract drawing or the Administrative Procedures, the most stringent requirement within any of these documents shall prevail.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

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SECTION 014000 - QUALITY CONTROL TESTING SERVICES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections, "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 GENERAL

- A. The Contractor is responsible for verifying and enforcing compliance with all requirements of the Contract Documents. Contractor's responsibility includes, but is not limited to, the following:
 - 1. Supervision of field work to enforce contract compliance of all construction activity.
 - 2. Verification of compliance with plans and specifications of all manufactured materials or equipment. Provide certificates of compliance, or other approved proof of compliance, by the manufacturers and submit to the Professional.
 - 3. Performance of all necessary field measurements and/or inspections to verify compliance with requirements of the plans or specifications requiring adherence to measurable standards of field performance.
 - 4. Engaging an independent testing laboratory to perform tests and inspections as required by this specification section, hereafter referred to as Quality Control Testing and Inspection Services or Quality Control Testing Services.
 - 5. Providing support services for all Quality Control Services, including cutting and patching and repair or replacement as required.
- B. Work not included: Quality Assurance Services by the Department are specified in Section 014010. The Department reserves the right to perform tests under the Quality Assurance Testing program and to use those as the basis for approval or rejection at its sole discretion.

1.03 DESCRIPTION OF QUALITY CONTROL TESTING

- A. Quality Control Services include inspections, tests and reports by an independent testing laboratory or other approved agency, hereafter referred to as the Quality Control Agency. All Quality Control Services shall be at the Contractor's cost, which shall be included proportionally in all items of payment or contained in any Base Bid or Unit Price on the Proposal. Tests and Inspections are to include those specifically required by this section and within technical sections of the Project Manual.
- B. The Quality Control Agent shall submit a Testing and Inspection Plan to the Professional for its approval, and the approval of the Quality Assurance agent for all tests and inspections required by this section and within technical sections of the Project Manual.
- C. Quality Control Services by a Quality Control Agency or Agencies is intended to assist in the determination of probable compliance of the work with requirements specified or indicated and do not relieve the Contractor of the responsibility for compliance with Contract Document requirements.

- D. Specific testing or inspections of a structural nature required to be performed by independent Quality Control Agencies for individual construction activities are specified in this Section only. If testing or inspection requirements appear in this section and a technical section, the most stringent requirements shall prevail. If Quality Control Testing or Inspection is specified in a technical section and not in this section, it shall be required as if specified in this section. Non-structural tests and inspections are in the technical specifications.
- E. Inspections, tests and related actions specified are not intended to limit the Contractor's quality control procedures that facilitate compliance with Contract Documents requirements.
- F. Quality Control Services required by the local municipality or other governing authorities are the responsibility of the Contractor, regardless of whether or not specified hereinafter or in the applicable specification section.
- G. Each prime Contractor will pay for all costs in connection with its Quality Control Services. Whenever the word "Contractor" is used it shall be interpreted to mean Prime Contractor or Contractors as applicable. All Contractors performing work for which testing or inspection is required by this section are required to perform said tests/inspections appropriate for the quantity of work performed as indicated by this specification section and as required by all Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 RESPONSIBILITIES AND DUTIES OF CONTRACTOR

- A. The Contractor shall engage Quality Control Agencies to provide all Quality Control Services required to comply with the Contract Documents. These services shall be at no cost to the Department.
- B. The Contractor is responsible for retesting where results of required inspections, tests or similar services prove unsatisfactory and indicate non-compliance with Contract Document requirements. Likewise, the Contractor is responsible for retesting when the Department's Quality Assurance Test results prove unsatisfactory. If Quality Assurance Tests were in error, the Contractor shall be reimbursed for his retesting costs.
- C. Cost of retesting construction revised or replaced by the Contractor is the Contractor's responsibility.
- D. Provide the Quality Control Agency with preliminary representative samples of materials to be tested in quantities requested. If the source, quality or characteristics of an approved material changes or indicates lack of compliance with Contract requirements, submit additional samples of materials to the Quality Control Agency.
- E. When requested by the Professional, the Department, or the Quality Control Agency, the Contractor shall immediately provide reports, cutting lists, material bills, shipping bills, time and place of shipment of materials to shop and field and any relevant data on previous testing and investigations of materials.
- F. Provide casual labor and facilities:

1. To provide access to the work inspected or tested by any authorized party.
 2. To obtain and handle samples at the site.
 3. To facilitate inspections and tests by the Quality Control Agency or Quality Assurance Agency.
 4. For security and protection of samples and test equipment at the project site.
- G. To facilitate the timely sequence of inspection and testing, the Contractor shall give advanced notification to the Quality Control Agency and the Department that work has progressed to a point where inspection and testing may proceed.
- H. Contractor shall pay for additional cost of Quality Control Agency services which, in the opinion of the Professional and the Department, are required because of the following:
1. Failure of materials or workmanship to meet Contract requirements.
 2. Materials or practices not complying with the technical specifications which could possibly result in defective and unacceptable work.
 3. Changes in source, quality or characteristics of materials.
 4. Site cured concrete cylinders requested by the Contractor.
- I. The Quality Control Agency shall submit a certified written report of each inspection, test or similar service to the Design Professional, the Quality Assurance Agent, the Bureau of Construction Regional Director, Project Manager and Assistant Project Manager, and the Contractor, with additional copies directly to any governing authority when that authority so directs. All reports shall be uploaded to e-Builder within 24 hours of when the inspection occurs, test is conducted, test results obtained or similar service was conducted.
- J. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:
1. Date of issue.
 2. Project title and number.
 3. Name, address and telephone number of testing agency.
 4. Dates and location of samples and tests or inspections.
 5. Names of individuals making the inspection or test.
 6. Designation of the Work and test method.
 7. Identification of product and specification section.
 8. Complete inspection or test data.
 9. Test results and an interpretation of test results.
 10. Ambient conditions at the time of sample taking and testing.
 11. Comments or professional opinion as to whether inspected or tested work complies with Contract Document requirements.
 12. Name and signature of Quality Control Agency inspector.
- K. The QC Agent shall cooperate in using standard forms/procedures developed by the Department that assist in accomplishing the tasks required.
- L. Engage independent testing laboratories, whose employees assigned to the Project and tests performed comply with ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction. The testing laboratory must be accredited and audited by a qualified national authority. The Contractor is to submit the name and credentials of the proposed QC Agent to the Design Professional and the Department for acceptance.

- M. Upon completion of inspection, testing, sample taking and similar activities, repair the damaged work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed finishes. Comply with the Contract Document requirements for "Cutting and Patching". Protect work exposed by or for Quality Control Testing activities, and protect repaired work.
- N. All required testing/inspection, including that stated in the body of the technical specification sections (be it referenced in the technical specifications as "Quality Control", "Quality Assurance", or any other referenced testing and/or inspection) shall be performed by the Contractor, unless it explicitly states it shall be performed by the Department. If stated to be performed by the Department, the Contractor shall still be required to perform all necessary testing/inspection in advance of the Department to assure the work meets all the requirement of the contract documents.
- O. Contractor shall coordinate closely with the Department, the Professional and the Professional's QA Agencies and Consultants so that any required or desired QA testing can be performed concurrently or immediately after the Contractor's QC testing.

3.02 RESPONSIBILITIES AND DUTIES OF QUALITY CONTROL AGENCIES

- A. Quality Control Agencies engaged to perform inspections, sampling and testing of materials and construction shall cooperate with the Professional, the Quality Assurance Agent, the Department, the Department of Labor and Industry, and the Contractor in performance of its duties, and shall provide qualified personnel to perform required inspections and tests. If it is determined by the Department that the personnel provided are not qualified or are not working in the best interests of the Project for the tests performed, the Contractor, through their Quality Control Agent, shall immediately replace or supplement the subject personnel.
- B. **Quality Control Agencies shall notify the Department, the Quality Assurance Agent, the Professional, and the Contractor immediately of irregularities or deficiencies observed in the Work during performance of its services.**

END OF SECTION

SECTION 014010 - QUALITY ASSURANCE TESTING AND INSPECTION SERVICES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 GENERAL

- A. All testing and inspecting specifically called for and/or described in this section of the specifications are referred to as Quality Assurance Services and are the responsibility of the Quality Assurance Agency. Except as hereinafter specified, Quality Assurance Services will be performed without expense to the Contractor. The Quality Assurance Agency is an independent testing and inspecting agency engaged by the Department through the Professional. Testing required because of changes in materials or proportions at the request of the Contractor shall be at the Contractor's expense. The Professional may engage more than one Quality Assurance Agency to perform services. Whenever the word "Contractor" is used it shall be interpreted to mean Prime Contractor or Contractors as applicable.
- B. Work Not Included: Quality Control Testing to be performed by the Contractor is specified in Section 014000.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 RESPONSIBILITIES AND DUTIES OF THE CONTRACTOR

- A. The use of Quality Assurance Services shall in no way relieve the Contractor of its responsibility to furnish materials and construction in full compliance with the plans and specifications or to perform Quality Control Testing where specified.
- B. **To facilitate Quality Assurance Inspection or Testing, the Contractor shall:**
 - 1. Secure and deliver to the project site, without cost, representative samples of materials it proposes to use and which are required to be tested under Paragraph 3.4, 'Tests and Inspections'.
 - 2. Furnish such casual labor as is necessary to obtain and handle samples at the project or at other sources of material.
 - 3. Provide means of safe access to work areas, provide conditions that allow testing and inspection to take place, provide materials for testing as requested, patch test sites when completed and furnish incidental labor and assistance necessary for inspectors of the Quality Assurance Agency to perform their tests and inspections.

3.02 AUTHORITY AND LIMITATIONS OF QUALITY ASSURANCE AGENCY

- A. Personnel representing the Quality Assurance Agency will not act as foremen nor perform other duties for the Contractor.
- B. Work will be checked as it progresses, but failure to detect any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the Department or the Professional for final acceptance.
- C. The Quality Assurance Agency is not authorized to revoke, alter, relax, enlarge, or release any requirements of the specifications, nor to approve or accept any portion of the work.
- D. The Quality Assurance Agency shall report all test and inspection results to the Professional, the Department and the Contractor immediately after they are performed. Selection and frequency of tests shall be at the discretion of the Professional and the Department. All reports shall be uploaded to e-Builder within 24 hours of when the inspection occurs, test is conducted, test results obtained or similar service was conducted.
- E. Written reports of each inspection, test or similar service shall include but not be limited to:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address and telephone number of testing agency.
 - 4. Dates and location of samples and tests or inspections.
 - 5. Names of individuals making the inspection or test.
 - 6. Designation of the Work and test method.
 - 7. Identification of product and specification section.
 - 8. Complete inspection or test data.
 - 9. Test results and an interpretation of test results.
 - 10. Ambient conditions at the time of sample taking and testing.
 - 11. Comments or professional opinion as to whether inspected or tested work complies with Contract Document requirements.
 - 12. Name and signature of Quality Control Agency inspector.
- F. When it appears that any material furnished or work performed by the Contractor fails to fulfill contract requirements, the Quality Assurance Agency shall report such deficiency to the Professional, the Department and the Contractor.

3.03 CONTRACTOR'S FAILURE TO MEET CONTRACT REQUIREMENTS

- A. The Department and the Professional reserve the right to reject any items which do not meet the requirements of the plans and specifications and will require the contractor to replace these items and bear all expenses in connection with such replacements.
- B. The Contractor shall pay all costs incurred in providing additional testing and/or analysis (including engineering fees) required because of deficient test results or construction not in compliance with requirements of the Contract Documents.

3.04 TESTS AND INSPECTIONS

- A. Tests and inspections listed below may, at the discretion of the Professional and the Department, be performed by an independent Quality Assurance Agency engaged by the Department through the Professional, without expense to the Contractor. The Department reserves the right to change this list at any time.**

END OF SECTION 014010

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SECTION 015000 - TEMPORARY UTILITIES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 TEMPORARY SERVICES DURING CONSTRUCTION

- A. The designated Contractor shall install, operate, protect and maintain the temporary services, as hereinafter specified, during the construction of the entire Project.
- B. Temporary connections to new and/or existing permanent service lines shall be made at the appropriate locations as determined by the designated Contractor, and coordinated with the Department, in conjunction with the Client Agency (as applicable). When the temporary service lines are no longer required, they shall be removed by the Contractor. Any part or parts of the permanent service lines, grounds and building, disturbed and damaged by the installation and/or removal of the temporary service lines, shall be restored to their original condition by the Contractor responsible for the temporary installation.
- C. If the Contractor fails to carry out its responsibility in supplying temporary services as set forth in this Contract, it is responsible for such failure, and the Department may take such action as it deems proper for the protection and conduct of the work, and shall deduct the cost involved from the amount due the Contractor. Only those temporary utilities required for construction need to be extended to the work area(s).
- D. Temporary utilities for Prime Contractors' office trailers shall be arranged and paid for by each responsible Prime Contractor. The Lead Contractor shall arrange, provide, install, and pay for all temporary utilities required for the DGS Construction Project Manager's office/ trailer.

1.03 TEMPORARY WATER SUPPLY

- A. The Plumbing Contractor shall install, operate, protect and maintain an adequate water supply during the period of construction, either by means of the permanent water supply line, or by the installation of a temporary water supply. The temporary water supply shall be in place within fifteen (15) days of any Prime Contractor's written request for such services.
- B. The temporary heat requirements on this Project are divided into two (2) categories: (1) temporary heat required prior to the enclosure of the building, buildings, or portions thereof; and (2) temporary heat required subsequent to the enclosure of the building, buildings or portions thereof.
- C. A building or portion thereof shall be considered to be enclosed when (a) the roof is on and tight; (b) the exterior walls have been completed; and (c) when openings, doors and windows

are closed with permanent closures, or with substantial temporary closures which will affect the retention of heat within the building or portion thereof.

- D. Prior to enclosure of building, buildings or portions thereof, and when official local weather predictions indicate below freezing temperatures or temperatures that may damage the work, each Contractor shall provide, maintain, operate and pay all costs, including fuel, for a sufficient number of approved portable heaters, so that the progress of its work is not impeded, and proper protection of its work from freezing is maintained. Self-contained oil
- E. After the building, buildings or portions thereof are enclosed, and temporary heat is required for proper construction, the HVAC Contractor, at its own cost and expense, shall provide equipment and heating personnel for the temporary heat. The HVAC Contractor may, with the Department's
- F. Temporary heating system, as hereinafter noted, shall be of sufficient capacity to heat the interior of the building to 60
- G. Where electricians or plumbers are required to install, operate supervise or maintain equipment used in the provisions of temporary heat, the payment of the services of such material and personnel shall be the responsibility of the Electrical and the Plumbing Contractors respectively. It will be the responsibility of the Electrical and Plumbing Contractors to coordinate with the HVAC Contractor for temporary heat.
- H. The Lead Contractor shall pay for all fuel and electricity for the temporary heat in conjunction with the operation of heating equipment for enclosed buildings, or enclosed portions thereof, unless provided by the
- I. The Lead Contractor shall remove normal soot, smudges, and other deposits from walls, ceilings and exposed surfaces which are the result of the use of any temporary heating equipment after enclosure, including the use of the permanent heating system for temporary
- J. All permanent heating equipment used to supply temporary heat shall be completely cleaned and reconditioned by the HVAC Contractor, in the presence of the Department personnel, prior to Final Acceptance. Cleaning of
- K. The cost of temporary heat shall be made a part of the lump sum bid submitted by each Contractor, as applicable. The cost of temporary heat after enclosure shall be shown on the Contract

1.04 CONSTRUCTION LIGHT AND POWER

- A. The Electrical Contractor shall install, operate, protect and maintain the temporary service for construction light and power. The Contractor shall extend the temporary wiring throughout the project work areas, properly insulated and installed in accordance with Article 300 of the National Electrical Code. All wiring shall be installed by a licensed electrician. The temporary construction lighting and power shall be extended from the existing power supply. Coordinate location of power supply with the Facility. Remove temporary construction lighting and power after construction is complete.
- B. The Electrical Contractor shall provide all transformers necessary to provide temporary power.

1.05 WELDING

- A. Any Contractor using electrical power for welding on the site shall use self-contained engine generating units.
- B. Each Contractor shall provide necessary exhaust/ventilation/filtration to prevent accumulation of welding fumes and smoke generated by welding their operations.
- C. Each Contractor shall have all precautions and protection in place while welding to assure no sparks cause fire or smoke damage to all surrounding areas; during and after all welding activities.

1.06 FIRE EXTINGUISHERS

- A. Each Contractor shall provide UL listed, NFPA approved fire extinguishers, ten (10) lb. minimum, at the construction site during operations, suitable for all types of fires in accordance with OSHA.

1.07 INTERRUPTION OF SERVICES

- A. Each Prime Contractor shall have all needed equipment and material to complete planned work at the site, prior to shutting down any system.
- B. No additional compensation or time will be given to the Contractor, if work must be performed on State or National Holidays or on weekends or on overtime. See paragraph on 'Working Hours' under Section 010400.

1.08 SNOW/ICE REMOVAL

- A. The Lead Contractor shall be responsible to provide snow removal and anti-skid material into to site and at the project site and indicated laydown areas (including construction trailer), unless directed otherwise.
- B. All related work shall be performed to provide proper and safe access throughout the site subsequent to each related work day. Any delay and potential related costs generated by failure to meet this requirement shall be the responsibility of the Lead Contractor.

1.09 DEWATERING

- A. Each Prime Contractor shall provide adequate attention, equipment and manpower to the project to assure the work area is dewatered as required to eliminate ponding, excessive water, depressions, etc. as affected by and for their work activities. Such action shall occur no later than 24 hours after a rain or water producing event. This effort shall be sustained for the time period necessary to bring the affected area back into conformance.

1.10 HOISTING FACILITIES

- A. Each Prime Contractor must provide hoisting facilities for its own work. All hoisting facilities must comply with the safety regulations of the Department of Labor and Industry.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 016400 - CAPITOL COMPLEX SECURITY PROGRAM AND CONTRACTOR REQUIREMENTS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections " General Conditions of the Construction Contract ", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 DGS SECURITY PROGRAM *FOR THE CAPITOL COMPLEX*

- A. Purpose: The purpose of the security program is to establish policy and procedures for contractor access to the Capitol Complex and other state office buildings. The policy and procedures outlined in this directive will enable contractors to gain safe access to buildings identified in the contract documents.
- B. Scope: This security program applies to all Commonwealth employees and contracted personnel under the Governor's jurisdiction and those employed by independent agencies as well as other individuals and organizations with offices or work locations in the Capitol Complex and other state office buildings.
- C. Definitions: For purposes of this security program, the following words and phrases shall be defined as:
 - 1. Biometric Reader: A device that reads the electronic encryption on an access card and makes an automatic non-invasive assessment of a unique body feature whereby access control systems may be activated.
 - 2. Building Maintenance Spaces: Data closets; air handling equipment rooms; major electrical and building services spaces.
 - 3. Core Buildings: Capitol Building (including the Main Capitol Building and its East Wing); Ryan Building; North Office Building; Speaker K. Leroy Irvis Building; connecting tunnels.
 - 4. Capitol Complex: Core buildings plus Forum Building, Finance Building, Health and Welfare Building, Labor and Industry Building, Keystone Building, Northwest Office Building, Judicial Center, Rachel Carson Building, Strawberry Square and State Museum.
 - 5. Other State Office Buildings: Department of Agriculture; DGS Annex Complex (formerly the Harrisburg State Hospital complex); DGS Public Works at 18th and Herr Streets; DGS at 22nd and Forster Streets; Harrisstown #1, Harrisstown #2, Commonwealth Tower; Philadelphia, Pittsburgh, Scranton and Reading state office buildings.
 - 6. Capitol Police Security Administration: The Capitol Police Security Administration under the Superintendent of the Capitol Police is responsible for establishing procedures for issuance of photo identification badges and photo identification access badges. The Capitol Police Security Administration produces photo identification badges and photo identification access badges, including the "Emergency Response" designation and maintains photo identification access badge permissions.
 - 7. Card Reader: A device that reads the electronic inscription on an access badge whereby locks or other access control systems may be activated.
 - 8. DGS: Department of General Services.
 - 9. Emergency Response Designation: A red banner with "Emergency Response" printed on the photo identification access badge or a photo identification badge. This designation is

determined by the agency and allows the individual access to state offices during an emergency.

10. Photo identification access badge: A card with an employee's photograph, name and department programmed to permit access through use of a card reader or a photo identification badge programmed to permit access through the use of a card reader.
11. Photo Identification Badge: A card with the individual's photographs, name and association issued to a registered lobbyist, the employee of a contractor or credentialed press for presentation at a visitor entrance.

D. Policy and Procedures for Contracted Personnel: The following policy and procedures are in place to ensure that personnel of all contracted firms, companies and associations are approved to perform work or provide services in the Harrisburg Capitol Complex and other secured buildings and premises. This does not include suppliers, visiting vendors or delivery persons who must enter through secured visitor's entrances.

1. Contracted personnel who will be on the premises during the business day (Monday - Friday, 6am-6pm) for less than two weeks will NOT need identification badges, and will be admitted to buildings through the security checks at visitor's entrances. All contracted personnel who will be on the premises for more than two weeks during the business day, or after business hours, on weekends and on holidays, MUST HAVE identification badges and are considered to be prime contracted personnel.
2. The DGS Bureau of Construction Staff/Construction Manager oversees and coordinates the various phases of work performed by contracted persons (including subcontractors, their subcontractors and suppliers) and insures the general conditions and all requirements of the project are met for the Commonwealth. This includes security related issues for contractor access and compliance with the Request for Criminal History Record Information Act check (CHRIA) performed by the Pennsylvania State Police.
3. The BOC Staff/Construction Manager will ensure that contracted personnel have complied with the criminal history background check process. Personnel requiring photo identification badges must present a cleared CHRIA report and photo identification to Security Administration before the badge is issued. To cover costs incurred by DGS in processing requests for badges by contracted personnel, a processing fee of \$10.00 for a photo identification badge or \$20.00 for a photo identification access badge must be paid by the Contractor before a badge will be issued. Badges that have been damaged, destroyed, stolen or lost through negligence will be replaced only after payment of a replacement fee of \$25.00 for a photo identification access badge or \$15.00 for a photo identification badge. Payment for badges will be in the form of check or money order payable to the Commonwealth of Pennsylvania.
4. Scheduling of Photos: BOC Staff/The Construction Manager will advise Capitol Police Security Administration of individuals requiring appointments for photo identification. The BOC Staff/Construction Manager will do all communication regarding photo appointments. If you have any questions, please contact the BOC Staff/Construction Manager.
5. Badges: The appropriate identification badge will be issued to contracted persons who have a clear CHRIA report. If a CHRIA report reflects a positive criminal history, the Bureau of Police and Safety will make appropriate review and enforce its denial policy where required. Individuals with a background that is deemed a security risk will not be issued an identification badge. The badge will be issued for a one year period from the date of request on the PA State Police Background Check. Badges subject to renewal will be coordinated in the same manner as new issue badges. A new CHRIA certification and processing fee are required each year. Capitol Police Officers will be required to check expiration dates and decline access to those whose badges have expired dates with no exceptions. All badges must be returned to the Construction Manager at the completion of a project or contract. The Construction Manager must return terminated badges to the Capitol Police Security Administration. The Contractor is responsible for

- paying the replacement/lost badge fee for any badge not returned at the completion of the project. This will be done by a credit Change Order.
6. CHRIA: To obtain your CHRIA report, access the following website: <https://epatch.state.pa.us>. Fill out the information form and use your credit card. If you have no criminal history, you will receive a clear CHRIA report almost immediately. Click on the control number and then certified form. Print the certified form. Security Administration will only accept the certified form that contains the state seal. If there is a criminal history it will be sent by mail. The CHRIA must be submitted to the BOC Staff/Construction Manager along with the processing fees, and the Construction Manager will submit all information to the Security Administration Office. The BOC Staff/Construction Manager will inform the Contractor when the badge(s) are ready for the Contractor to pick up.
 7. All badges must be returned to the BOC Staff/Construction Manager at the completion of a project or contract. The BOC Staff/Construction Manager must return terminated badges to the Capitol Police Security Administration. The employer of contracted personnel is responsible for paying the replacement/lost badge fee, for any badge not returned at the completion of the project.

1.03 CONTRACTOR REQUIREMENTS FOR THE SECURITY PROGRAM

- A. Each Prime Contractor shall designate a security coordinator to coordinate security issues with its subcontractors and the BOC Staff/Construction Manager.
- B. The security program must be maintained throughout the construction period until final completion.
- C. For new badges, the CHRIA must be submitted to the BOC Staff/Construction Manager 48 hours prior to the scheduled photo appointment; for renewals, no less than 24 hours prior to the individual starting work on the project. Upon submittal of the CHRIA, the security coordinator must inform the BOC Staff/Construction Manager as to the DGS Project Name and No. their personnel will be working on.
- D. The security coordinator for each prime contractor must contact the BOC Staff/Construction Manager to coordinate and schedule an appointment to obtain photo identification badges for all of their employees as well as the employees of sub-contractors or suppliers.
- E. All employees shall display the photo identification badge at all times.

1.04 ACCESS TO OCCUPIED/SECURED AREAS REQUEST

- A. All Contractors' employees must have an approved written request for access to all occupied/secured areas of a building. Employees who enter areas other than those designated on the approved written request will be immediately escorted from the site and will not be permitted to return.
- B. The following procedures are presented to establish a consistent and trackable method for the request and authorization of access for occupied/secured areas in the Capitol Complex. The intent is to streamline the process to minimize construction delays and to inform the Client Agencies and Security Agencies of contractor activity in a timely manner. All access requests will be processed through the Construction Manager. The Request for Access procedure established is outlined below:

1. The "Request for Access to Occupied/Secured Areas" form should be fully completed by the Contractor and faxed/emailed to the Construction Manager. This request is to be made no later than 72 hours prior to the requested access date (see Attachment #1).
2. Upon receiving the request from the Contractor, the Construction Manager will request approval from the affected Client Agency and/or Security Agency.
3. The notification of approval will be made via fax or email transmission to the Contractor and DGS once received from the Client Agency and Security Agency. Denials will be communicated to the Contractor via phone, fax and email to explain the reason for the denial and to re-schedule the access.
4. Cancellation of access by the Contractor must be submitted to the Construction manager in writing at least (8) eight hours prior to the start time.

1.05 DELIVERY NOTIFICATIONS

- A. All Contractors' employees must have written notification to deliver goods and/or services to the Capitol Complex. Employees who attempt to deliver items without prior notification may be denied access to the delivery area and may not be permitted to return until written notification has been submitted.
- B. The following procedures are presented to establish a consistent and trackable method for the notification of the delivery of goods and services to the Capitol Complex. The intent is to streamline the process to minimize construction delays and to inform the Client Agencies and Security Agencies of contractor activity in a timely manner. All delivery notifications will be processed through the BOC Staff/Construction Manager. The Delivery Notification procedure established is outlined below:
 1. The "Delivery Notification" should be completely filled out by the Contractor and faxed or emailed to the BOC Staff/Construction Manager. This request is to be made not later than 24 hours prior to the requested delivery (see Attachment #2).
 2. Upon receiving the notification from the Contractor, the BOC Staff/Construction Manager will notify the Security and Client Agency. The contractor should ensure the delivery driver has a copy of the delivery notification at the time of delivery.

1.06 UTILITY SHUTDOWN REQUESTS

- A. All Contractors' employees must have written approval for a Utility Shutdown in any area involving the Capitol Complex.
- B. The following procedures are presented to establish a consistent and efficient method for the request and approval of a utility shutdown to services at the Capitol Complex. The intent is to streamline the process to minimize construction delays and to inform the Client Agencies and Security Agencies of contractor activity in a timely manner. All utility shutdown requests will be processed through the BOC Staff/Construction Manager. The utility shutdown procedure established is outlined below:
 1. The "Request for Utility Shutdown" should be completely filled out by the Contractor and faxed or emailed to the BOC Staff/Construction Manager. This request is to be made no later than two (2) weeks prior to the requested shutdown (see Attachment #3).
 2. Upon receiving the shutdown request from the Contractor, the BOC Staff/Construction Manager will request approval from the affected Client Agency and/or Security Agency.
 3. The notification of approval will be made via fax or email transmission to the Contractor and DGS once received from the Client Agency and/or Security Agency. Denials will be

communicated to the Contractor via phone, fax and email to explain the reason for the denial and to re-schedule the shutdown.

4. Cancellation of shutdown by the Contractor must be submitted to the BOC Staff/Construction manager in writing at least eight (8) hours prior to the start time. Failure to notify the BOC Staff/Construction Manager may result in back charges to the contractor via credit change order for overtime fees expended by state personnel that may be scheduled to work solely due to the requirements of the contractor shutdown.
5. A shutdown coordination meeting is required with all shutdown requests. The Construction Manager will coordinate this meeting between the Contractor, subcontractors, vendors, suppliers, Client Agencies and/or Security Agencies.

1.07 HOT WORK PERMITS

- A. A construction fire can be the single most devastating event to affect a project. Contractor's employees must be thoroughly briefed and familiar with the applicable practices of the National Fire Protection Association.
- B. Any hot work being performed requires the Contractor to complete a hot work request using the "24 Hour Notice Fire/Safety Work Permit" form. A separate request is necessary for each area where hot work is being performed. Upon DGS Fire/Safety approval, the Contractor can perform hot work as indicated on the request. The Contractor is required to have a copy of the signed "24 Hour Notice Fire/Safety Work Permit" form at the location of hot work.
- C. The DGS Fire/Safety personnel will periodically check the job during the shift for conformance to the hot work request; any individual not in compliance with the request will be removed from the project. The Contractor performing this work shall be totally responsible, legally and financially, for any damage that may occur as a result of this work. The procedure for acquiring a hot work permit is outlined below:
 1. The Contractor will request and receive the "24 Hour Notice Fire/Safety Work Permit" form electronically from the Construction Manager (see Attachment #4). This is an electronic PDF form with dropdown boxes to make selections. The contractor will be required to complete this form electronically.
 2. All Contractors must have an approved "24 Hour Notice Fire/Safety Work Permit" form prior to performing any hot work.
 3. A "24 Hour Notice Fire/Safety Work Permit" form is required under the following hot work descriptions:
 - a. Chemical Use
 - b. Cooking
 - c. Cutting
 - d. Grinding
 - e. Insulation
 - f. Ladder Work
 - g. Painting
 - h. Restoration
 - i. Sandblasting
 - j. Soldering
 - k. Static Displays
 - l. Sterno
 - m. Welding
 - n. Other Contact Fire/Safety with Explanation

4. Upon fully completing the "24 Hour Notice Fire/Safety Work Permit" form, the Contractor shall email to the Fire and Safety Agency (gs-firesafetyenv@state.pa.us) and copy the DGS Bureau of Construction and the Construction Manager, with at least a 24 hour period before the hot work commences. The Fire and Safety Agency will either approve or advise if other requirements are necessary and email back to contractor, DGS Bureau of Construction and the Construction Manager.
5. Contractor must comply with all instructions on the form and the checklist. They must have the form in their possession while performing the hot work.

PART 2 - PRODUCTS - Not Used

PART 3 - EXECUTION - Not Used.

END OF SECTION

Attachment #1
January 16, 2009

Request for Access to Occupied/Secured Areas

Date: DGS Project No.:

Contractor: Subcontractor (if applicable):

Point of Contact:

Phone/Cell/Pager:

Building:

Room No(s):

Date(s) of Proposed Access:

ExactTime(s) of Proposed Access:

Scope of Work to be Performed/Crew Size:

Hot work will be performed during this access: YES NO

COMPLETE FORM AND FAX OR EMAIL TO CONSTRUCTION MANAGER (CM)

CM Contact Person:

CM Contact Fax:

CM Contact Email:

CM Contact Phone:

Do not write below this line – for Department of General Services Use Only

If this access is acceptable, please sign below and this approval will be sent to all contractors requiring access. If there are modifications to this schedule, please note accordingly and we will distribute. Thank you in advance for your assistance.

Authorizing signature and date:
(email response is acceptable)

Attachment #2
January 16, 2009

Delivery Notification

Date:		DGS Project No.:	
Contractor:		Subcontractor (if applicable):	
Point of Contact:			
Phone/Cell/Pager:			
Driver:		Badge:	Yes No
Vehicle year, make, model and color:			
License Plate No.:			
Exact Time(s) of Proposed Delivery:			
Date of Proposed Delivery:			
Where Delivery will take place:			
Who will receive Delivery/Contact info:			

COMPLETE FORM AND FAX OR EMAIL TO CONSTRUCTION MANAGER (CM)

CM Contact Person:

CM Contact Fax:

CM Contact Email:

CM Contact Phone:

Attachment #3
January 16, 2009

Request for Utility Shutdown

Date: DGS Project No.:

Contractor: Subcontractor (if applicable):

Point of Contact:

Phone/Cell/Pager:

Utility Proposed for Shutdown:

Date and Time Shutdown is Proposed to Start:

Date and Time Restart is Proposed:

Specific Area(s) to be Affected:
(Identify Room Nos. from floor plans included and no contract drawings)

Justification for Shutdown Request:

COMPLETE FORM AND FAX OR EMAIL TO CONSTRUCTION MANAGER (CM)

CM Contact Person:

CM Contact Fax:

CM Contact Email:

CM Contact Phone:

This Section to be completed by the Construction Manager (CM)

Request sent to (DGS Contact/Date):

Deadline for Response to CM:

Do not write below this line – for Department of General Services Use Only

DGS Authorizing signature and date:

DGS Rejection signature and date:

Attachment #4
January 16, 2009

****24 HOUR NOTICE ****
FIRE/SAFETY WORK PERMIT

Date of Request:		Work Order # DGS Project #	
Building:		Floor:	
Exact location:			
Exact Work Description: (Note) Select From Drop down List WELDING			
Exact Location:			
CONTRACTOR / AGENCY:			
Date of Work:	Start Time:	Finish Time:	
PERSON CONDUCTING WORK:		Fire Watch:	
SUPERVISOR:		Contact Phone #	
<u>THE FOLLOWING ITEMS ARE REQUIRED AND MUST BE ADHERED TO ACCORDINGLY OR WORK WILL BE DENIED OR RESCHEDULED</u> PERSONS CONDUCTING WORK THAT REQUIRES A FIRE/SAFETY PERMIT WILL ABIDE BY THE FOLLOWING: • Notify the DGS Building Manager and the DGS Fire Safety Office of any intended Hot Work via this form NOT LESS THAN 24 HRS NOTICE UNLESS DEEMED AN EMERGENCY. • ONCE THIS FORM IS COMPLETED IT MUST BE SUBMITTED ELECTRONICALLY. • Be responsible for fire protection in the work areas and staging areas • Supply and maintain all necessary fire protection equipment. • Provide a minimum of two APPROVED working fire extinguishers rated at 10 lb. ABC within each Work/Event area 75 ft. apart. • Provide a fire watch at all times while open flame operations are taking place and for one hour after completion of work. • Utilize a flame resistant pad to protect all adjacent surfaces from open flame. • Provide a smoke/dust elimination devices or negative air enclosure at work site. • Not permitted to leave the work area until the materials have reached a temperature where it can be touched with a non-gloved hand. Contact information for DGS Fire Safety Phone (717-772-4545) E-Mail to: GS-firesafetyenv@state.pa.us			
HOT WORK CHECKLIST			
☐	Fire alarm system is disabled or there is no risk of activation.		
☐	The area is swept clean of combustibles.		
☐	All movable combustible items have been moved away from Hot Work area.		
☐	All non-movable combustible flooring, building material, adjacent surfaces are covered with flame Resistant blankets.		
☐	Flame Resistant Pads / Tarpaulins suspended beneath work if working on walls or ceilings.		
☐	Hot Work is being conducted on Non-Combustibles and without Combustible Covering or Insulation.		
☐	Enclosed equipment (If at or adjacent to the Hot Work areas) is cleaned of all combustibles.		
☐	Containers adjacent to Hot Work area purged of ALL Combustible Materials.		
☐	Fire Watch is trained in use of Portable Fire Extinguishers and Sounding the Alarm.		
DISABLED POINT (S) OR LOOP (S)			
Approval date:		Approval Time:	
Date Posted:		Time Posted:	
DGS FIRE / SAFETY APPROVAL:			

SECTION 019100 - COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.01 STIPULATIONS

- A. The Specifications Sections "General Conditions of Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the Client Agency's project requirements and operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
 - 2. Verify and document proper performance of equipment and systems.
- C. The commissioning process does not take away from or reduce the responsibility of the installing contractors to provide a finished and fully functioning product.

1.03 REFERENCES, RESOURCES

- A. ASHRAE Guideline 0-2005: The Commissioning Process, ASHRAE, 2005
- B. ASHRAE Guideline 1.1-2007: HVAC&R Technical Requirements for the Commissioning Process, ASHRAE, 2007
- C. ASHRAE Guideline 4-1993: Preparation of Operations & Maintenance Documentation for Building Systems, ASHRAE, 1993

1.04 DEFINITIONS

- A. Use of terms and abbreviations referring to the Controls Subcontractor (CC) shall be understood to mean the Subcontractors to the HVAC Contractor for these specific portions of the Work.

1.05 COORDINATION

- A. Commissioning Team. The members of the commissioning team consist of the Commissioning Authority (CxA), the DGS Representative (DGS), the Using Agency representative (UA), the General Contractor (0.1 Contractor), the Professional, the HVAC Contractor (0.2 Contractor), the Plumbing Contractor (0.3 Contractor), the Electrical Contractor (0.4 Contractor), the Controls

Subcontractor (CC), any other installing subcontractors or suppliers of equipment. The Using Agency's facilities staff is also a member of the commissioning team.

- B. Management. The CxA for this Project has been hired by the Department. The CxA directs and coordinates the commissioning activities and reports to the Department and the Professional.
- C. Scheduling. The CxA will provide the initial schedule of primary commissioning events using the information gathered from the commissioning scoping meeting. The Commissioning Plan provides a format for this schedule. The timeline is fine-tuned as construction progresses. In particular, 30 days prior to startup of the primary HVAC equipment, the CxA meets with the DGS, UA and Contractors and develops a detailed commissioning schedule. The CxA will approve the commissioning schedule.

- 1. Lead Contractor shall coordinate requirements of Construction Scheduling with this work.

1.06 COMMISSIONING PROCESS

- A. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted to the CxA, electronically through E-Builder, during normal submittals, including detailed start-up procedures.
 - 4. The Contractors develop the full start-up plan by combining the manufacturer's detailed start-up and checkout procedures from the O&M manual and the CxA provided Prefunctional Checklist to be completed by the Contractor. See Design Phase Cx Plan attached to this section for more information, including the Prefunctional checklists.
 - 5. The Contractors submit all completed startup plan documentation to the CxA for review and approval.
 - 6. The CxA develops and documents functional performance test procedures. The contractor and/or his controls sub-contractor will perform the functional tests per the procedures developed by and provided by the CxA. CxA will witness and document testing on the functional test forms. See Design Phase Cx Plan attached to this section for more information, including Functional Test Forms for each type of meter.
 - 7. Items of non-compliance are resolved at commissioning meetings.
 - 8. Items of non-compliance in material, installation or setup are corrected at the Contractor's expense and the system retested.
 - 9. Contractor / manufacturer equipment start-ups, controls installation and programming are completed four weeks prior to Substantial Completion. This includes submission of all associated documentation to the CxA, which is required to allow sufficient time for the CxA's Functional Testing. Contingent on these items and weather conditions, functional testing may be completed prior to occupancy.
 - 10. Warranty testing is conducted 10 months after project completion.

1.07 RESPONSIBILITIES

- A. The responsibilities of various parties in the commissioning process are provided in this section. The responsibilities of the Plumbing Contractor are in Section 220800. The responsibilities of the

HVAC Contractor and Controls Subcontractors are in Section 230800. The responsibilities of the Electrical Contractor are in Section 260800. It is noted that the services for the DGS Representative, Architect, mechanical and electrical designers/engineers, and Commissioning Authority are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process.

B. All Parties

1. Attend the initial commissioning meeting conducted at the start of construction, the commissioning meeting held 30 days prior to startup of the primary equipment, and additional meetings, as necessary.

C. Professional

Construction and Acceptance Phase

1. Perform normal submittal review, construction observation, record drawing preparation, and O&M manual approval in accordance with Division 1, etc., as contracted.
2. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
3. Prepare and submit final record basis of design documentation for inclusion in the Commissioning Reports.

Warranty Period

4. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

D. Mechanical and Electrical Designers/Engineers (of the Professional)

Construction and Acceptance Phase

1. Perform normal submittal review, construction observation, record drawing preparation, and O&M manual approval in accordance with Division 1, etc., as contracted.
2. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
3. Prepare and submit the final record basis of design and operating parameters documentation for inclusion in the O&M manuals.

Warranty Period

4. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

E. Commissioning Authority (CxA)

The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving, non-conformance or deficiencies, but ultimately that responsibility resides with the contractor and the Professional. The primary role of the CxA is to ensure that the Using Agency's project requirements are achieved through the construction and operation of the facility.

Construction and Acceptance Phase

1. Installation Observation: the CxA shall observe installation of each type of commissioned feature and system to ensure that they are properly installed according to the contract documents and manufacturers' instructions and that other building systems or components are not compromising the performance of the feature.

2. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
3. Coordinate the commissioning work and, with the Lead Contractor and DGS, ensure that commissioning activities are being scheduled into the master schedule.
4. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.
6. Recommend approval of systems startup by reviewing start-up reports and by selected site observation.
7. Oversee sufficient construction and startup (construction checklist) of the control system and review the final point-to-point checkout completed by the Controls Contractor.
8. Develop and document functional performance test procedures.
9. Maintain a corrective action list and a separate testing record. Provide to the Department written progress reports and test results with recommended actions.
10. Review equipment warranties to ensure that the Department's responsibilities are clearly defined.
11. Provide a final commissioning report. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report shall contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:
 - a. Equipment meeting the Using Agency's project requirements
 - b. Equipment meeting the equipment specifications
 - c. Equipment ensuring proper installation
 - d. Functional performance and efficiency
 - e. Equipment documentation
 - f. All outstanding non-compliance items shall be specifically listed.
 - g. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

Warranty Period

12. Coordinate and supervise required seasonal or deferred testing and deficiency corrections and provide the final testing documentation for the commissioning record and O&M manuals.

F. DGS Representative (DGS)

Construction and Acceptance Phase

1. The Department manages the CxA contract.
2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions according to the Commissioning Plan—Construction Phase.
3. Provide final approval for the completion of the commissioning work.

Warranty Period

4. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

1.08 SYSTEMS TO BE COMMISSIONED

- A. The systems that shall be commissioned in this project include but are not limited to the following:
 - 1. Utility Metering Systems including Chilled Water & Steam.
 - 2. Building Automation System integration of all metering systems.
 - 3. Utility Metering Systems including Domestic Water & Natural Gas.
 - 4. Utility Metering Systems including Electrical.
 - 5. Data Infrastructure Communication Systems.

PART 2 – PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 MEETINGS

- A. Initial Commissioning Meeting. Within thirty (30) days of commencement of construction, the CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to prepare the *Commissioning Plan*, which will also be distributed to all parties.
- B. Equipment Startup Coordination Meeting. Thirty (30) days prior to startup of the primary HVAC equipment, the CxA meets with the DGS, UA, Professional and Contractors and develops a detailed commissioning schedule. Prior to this meeting, the Contractors shall submit to the CxA the full start-up plan.
- C. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Contractors.

3.02 REPORTING

- A. The CxA will provide regular reports to the Department, with increasing frequency as construction and commissioning progresses.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through progress reports.
- C. Testing or review approvals and non-conformance and deficiency reports are made regularly with the review and testing as described in later sections.

3.03 SUBMITTALS

- A. Copies of MEP shop drawings will be provided to CxA, when they are submitted to the Professional, electronically through E-Builder. CxA will review shop drawings concurrently with the Professional and provide any comments to the Professional so they may be included in their comments. Copies of approved shop drawings and startup reports for all commissioned equipment will be forwarded to the CxA through E-Builder. Supplement the shop drawing data

with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.

- B. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Professional will approve them.

3.04 START-UP AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned.
- B. General. Contractor start-ups are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full Contractor start-up. The start-up for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.
- C. Start-up and Initial Checkout Plan. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.
 - 1. The Contractors develop the full start-up plan by combining the manufacturer's detailed start-up and checkout procedures from the O&M manual and the CxA provided Prefunctional Checklist to be completed by the Contractor. The plan shall include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan. See Design Phase Cx Plan attached to this section for more information, including the Prefunctional checklists.
 - 2. The Contractors submit all completed startup plan documentation to the CxA for review and approval.
 - 3. For systems that may not have adequate manufacturer startup and checkout procedures, particularly for components being integrated with other equipment, the contractor should provide the added necessary detail and documenting format to the CxA for approval, prior to execution.
 - 4. The full start-up plan shall consist of:
 - a. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - b. The manufacturer's normally used field checkout sheets.
 - c. Prefunctional Checklists.
- D. Execution of Startup and Checkout Procedures.
 - 1. Thirty (30) days prior to startup, the contractors and vendors schedule startup and initial checkout with the DGS, UA, Professional and CxA. A commissioning meeting will be held at this time for all parties.
 - 2. The Contractors and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and checkout procedures and completed checklists.
 - 3. Only individuals that have direct knowledge and witnessed that a line item task on the checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

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

1. The Contractors shall clearly list any outstanding items of the initial start-up and checkout procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA will review the report and submits either a non-compliance report or recommend approval to the DGS. The installing Contractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will recommend approval of the start-up plan to the DGS.

3.05 FUNCTIONAL PERFORMANCE TESTING

- A. The Contractor shall execute all functional performance testing. The CxA will witness and document all performance testing. CxA will develop and provide the functional performance test forms. See Design Phase Cx Plan attached to this section for more information, including Functional Test Forms for each type of meter.
- B. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented Owner's Project Requirements (OPR), Basis of Design (BOD) and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
- C. Coordination and Scheduling. The Contractors shall provide sufficient notice to the CxA regarding their completion schedule for the startup of all equipment and systems. The CxA shall provide written notice of testing dates. In general, functional testing is conducted after startup has been satisfactorily completed. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting, individual systems has been achieved, the interface or coordinated responses between systems is checked.
- D. Problem Solving. The CxA will recommend solutions to problems found, however the burden of responsibility to solve and correct problems is with the Contractors and Professional.

3.06 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. Documentation. The CxA will document the results of all functional performance tests using the specific procedural forms developed for that purpose. The CxA will include the filled out forms in the Commissioning Record.
- B. Non-Conformance.
 1. If the Contractor is available, corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution shall be documented on the procedure form.

2. Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Department.
3. As tests progress and a deficiency is identified, the CxA discusses the issue with the executing contractor.
 - a. When there is no dispute on the deficiency, the Contractor accepts responsibility to document and complete the corrective action.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible, the deficiency shall be documented and submitted to the Professional and DGS for further review. Final interpretive authority is with the Professional. Final acceptance authority is with the DGS.
 - c. All deficiencies will be listed in a spreadsheet and provided to all parties. Responsible party will address the items and respond in writing to the CxA that each item has been addressed.
 - d. Contractor will retest each item of deficiency on the list. CxA will observe, document the testing and clear the items from the list.

3.07 WARRANTY PERIOD TESTING

- A. At ten months from project completion, the CxA shall complete warranty. The Professional shall coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning. Any final adjustments to the O&M manuals and record drawings due to the testing shall be made by the Contractors.

END OF SECTION 019100

SECTION 028111 - HAZARDOUS MATERIALS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 HAZARDOUS MATERIALS SURVEY REPORT

DRAFT
HAZARDOUS MATERIALS SURVEY REPORT

**PENNSYLVANIA DEPARTMENT OF GENERAL SERVICES
CAPITOL CONTROLS PROJECT
HARRISBURG CAPITOL COMPLEX
HARRISBURG, PENNSYLVANIA**

Project No. 2430

July 12, 2023

Prepared for:

Greenman-Pedersen, Inc.
52 Glenmaura National Boulevard
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Prepared by:

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EXECUTIVE SUMMARY

Rhea Engineers & Consultants, Inc. (Rhea) was contracted by Greenman-Pedersen, Inc. (GPI) to perform a hazardous materials survey of ten buildings (see Hazardous Materials Summary table below) associated with the Harrisburg Capitol Complex in Harrisburg, Pennsylvania (PA) (Figures 1 and 2). Hazardous materials surveys were conducted for suspect thermal systems insulation (TSI) asbestos-containing material (ACM) and lead-based paint (LBP) and/or lead-containing paint (LCP) within the central mechanical rooms of each of the ten buildings in support of the Pennsylvania Department of General Services (PADGS) Capitol Controls Project. This report documents the surveys of each mechanical room by a certified inspector for suspect TSI ACM, LBP and/or LCP.

The hazardous materials survey was conducted on June 22 and June 23, 2023 by Mr. Michael Stoehr (Registered PA Asbestos Inspector [#056261]) and Mr. Erik Hartle (Registered PA Asbestos Inspector [#063208]) of Rhea. Laboratory analysis of suspect TSI ACM samples was completed by Environmental Hazards Services, LLC (EHS) of Richmond, Virginia (VA).

The United States Environmental Protection Agency (USEPA) and Commonwealth of Pennsylvania define ACM as any material that contains greater than one percent asbestos. Title 40 of the Code of Federal Regulations (CFR), Part 61 (40 CFR 61), Subpart M (USEPA National Emission Standards for Hazardous Air Pollutants [NESHAP]) requires that an asbestos inspection be conducted prior to renovation/demolition activities. The Commonwealth of Pennsylvania also requires that asbestos inspections be conducted prior to renovation/demolition activities.

The USEPA defines LBP as paint, or surface coating, containing lead equal to or exceeding 1.0 milligrams per square centimeter (mg/cm^2) or 0.5 percent by weight. In addition, as per the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1926.62, paint containing any detectable concentration of lead is considered LCP and is subject to worker exposure regulations.

The purpose of this hazardous materials survey was to identify TSI ACM and LBP/LCP to support renovation activities associated with the PADGS Capitol Controls Project. It is assumed that all hazardous materials identified in this survey must be removed prior to renovation activities. The following table summarizes the identified hazardous materials within each building:

Hazardous Materials Summary		
Building Name	ACM Concern	LBP/LCP Concern
Department of Labor & Industry	No	Not applicable
Department of Health & Welfare	Yes	No
Finance Building	No	Not applicable
North Office Building	No	Yes
Capitol East Wing	No	Not applicable
Main Capitol Building	No	Not applicable
Museum	No	No
Speaker Matthew J. Ryan Building	No	Not applicable
South Office Building	No	No
Forum Auditorium	No	No

Suspect ACM was identified in each of the 10 buildings surveyed and a total of 19 homogeneous areas (i.e., materials of uniform texture, appearance, color, physical characteristics, function, and apparent date of application) were identified, sampled, and submitted for analysis by EHS. Two of the suspected materials, both of which are located in the Department of Health & Welfare mechanical room, were confirmed to be ACM by laboratory analysis (Table 1). It is also important to note that the “positive stop approach” was requested and implemented during this project. Using this approach, when the laboratory identifies a material as asbestos-containing, all other samples of the same material are not analyzed, under the assumption that those materials are also asbestos-containing.

All identified ACM should be properly removed and disposed of according to federal, state, and local regulations prior to renovation activities. Asbestos abatement specifications and cost estimate have been developed by Gary Case of Michael Baker International for the safe removal of the positively identified ACM listed in Table 1. Gary Case is a USEPA certified Building Inspector, Management Planner, and Project Designer for asbestos. The purpose of the asbestos abatement specifications is to provide the abatement contractor with the minimum requirements and constraints to facilitate the satisfactory execution of asbestos abatement. The project cost estimate includes total cost pertaining to the required documents/submittals (as per specifications), mobilization and demobilization from the Site, and the abatement, waste management, transportation, and disposal of the two identified positive ACM samples. The total cost estimate for the abatement of the positively identified ACM is \$1,500.00, to be completed in one 8-hour work day.

The asbestos abatement specifications and cost estimate were provided to GPI under separate cover.

Based upon the areas to be disturbed, as identified by GPI, LBP and/or LCP readings were collected via portable x-ray fluorescence (XRF) analyzer from the North, Health & Welfare, Museum, South, and Forum buildings. LBP and/or LCP readings were not collected from the remaining buildings as no painted surfaces are planned to be disturbed during renovation activities in these buildings. LCP was identified in the North building utility tunnel on the green cinder block wall and the red metal pipe (Table 2). The remaining readings were non-detect for LBP and LCP. No bulk paint samples were collected; however, general observations of the condition of the paint were documented to assist with renovation activities associated with the Capitol Controls project. The contractor should be aware of the LCP components in the North building utility tunnel if the LCP components are to be disturbed during renovation activities so that proper worker safety procedures can be implemented. The requirements of the OSHA Construction Standards need to be invoked if any metal content is present in the paint that may be affected by renovation activities. OSHA does not provide a minimum concentration criteria level for these metals; however, it requires precautions and protection for workers and the working environment be taken at any workplace where exposure to airborne metals may occur. The contractor shall be responsible for performing work according to all applicable federal, state, and local laws.

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ACRONYMS AND ABBREVIATIONS

ACM	Asbestos-Containing Material
CFR	Code of Federal Regulations
COC	Chain-of-Custody
EHS	Environmental Hazards Services, LLC
GPI	Greenman-Pedersen, Inc.
LBP	Lead-Based Paint
LCP	Lead-Containing Paint
mg/cm ²	milligrams per square centimeter
NELAP	National Environmental Laboratory Accreditation Program
NESHAP	National Emission Standards for Hazardous Air Pollutants
OSHA	Occupational Safety and Health Administration
PA	Pennsylvania
PADEP	Pennsylvania Department of Environmental Protection
PADGS	Pennsylvania Department of General Services
PLM	Polarized Light Microscopy
PPE	Personal Protective Equipment
RCRA	Resource Conservation and Recovery Act
Rhea	Rhea Engineers & Consultants, Inc.
SOW	Scope of Work
TSI	Thermal Systems Insulation
USEPA	United States Environmental Protection Agency
VA	Virginia
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

Rhea has completed a Hazardous Materials Survey of the central mechanical rooms in ten buildings (see Building Summary Table below) associated with the Harrisburg Capitol Complex in Harrisburg, PA (Figures 1 and 2). The central mechanical rooms in these buildings are scheduled to undergo renovation activities in support of the PADGS Capitol Controls Project. This Hazardous Materials Survey consisted of the identification, characterization, and documentation of suspect TSI ACM and LBP and/or LCP within the central mechanical rooms.

The Hazardous Materials Survey was conducted on June 22 and June 23, 2023, by Mr. Michael Stoehr (Registered PA Asbestos Inspector [#056261]) and Mr. Erik Hartle (Registered PA Asbestos Inspector [#063208]) of Rhea. The inspections included a detailed surface-by-surface investigation of the pre-defined areas to be renovated, as identified by GPI, within the central mechanical room of each building to determine the presence of TSI ACM and LBP and/or LCP (see Building Summary Table below). Copies of Rhea's professional licenses are included in Appendix A. Site access was coordinated with Mr. Corey Lex of PADGS.

Building Summary Table	
Building Name	Address
Department of Labor & Industry	651 Boas Street
Department of Health & Welfare	625 Forster Street
Finance Building	129 Finance Building
North Office Building	401 North Street
Capitol East Wing	Commonwealth Avenue
Main Capitol Building	501 N 3 rd Street
Museum	300 North Street
Speaker Matthew J. Ryan Building	451 N 3 rd Street
South Office Building	Commonwealth Avenue
Forum Auditorium	500 Walnut Street

Details related to each building, such as floor plans and the area to be disturbed in each mechanical room, were provided by GPI. It should be noted that Rhea was not provided with a floor plan of the South Office building. Prior to the Hazardous Materials Survey, Rhea personnel reviewed historical hazardous materials survey records for the Capitol Complex to determine if ACM had been previously identified

in the areas to be disturbed as part of the PADGS Capitol Controls Project. Previous survey records were identified for some buildings; however, as a conservative approach, samples were collected from each of the mechanical rooms.

1.1 Relevant Regulations

Relevant regulations and policies referenced for purposes of this investigation are summarized below.

- + The USEPA and OSHA define ACM as any material that contains greater than one percent asbestos.
- + Title 40 of the CFR, Part 61, Subpart M (USEPA NESHAP), and OSHA (29 CFR 1926.1101) require that an asbestos inspection be conducted prior to renovation/demolition activities.
- + The USEPA defines LBP as paint, or surface coating, containing lead equal to or exceeding 1.0 mg/cm² or 0.5 percent by weight. In addition, as per the OSHA Standard 29 CFR 1926.62, paint containing any detectable concentration of lead is considered LCP and is subject to worker exposure regulations.

2.0 ASBESTOS-CONTAINING MATERIALS SURVEY

2.1 Suspect Materials Sampled

Rhea collected samples of TSI from the pre-defined areas to be renovated, as identified by GPI, within the central mechanical room of each building listed on the Building Summary Table in Section 1.0 in accordance with the Scope of Work (SOW) approved by GPI. It is important to note that because ACM sampling was carried out in support of renovation activities, destructive sampling was required for certain materials. This effort entailed cutting or removing small areas of TSI to access and collect representative samples.

When identified within each unique building, suspect TSI was grouped into homogeneous sampling areas, which contained materials of uniform texture, appearance, color, physical characteristics, function, and apparent date of application. Each homogeneous material was then given a unique identification number. Once the homogeneous material boundaries were established, core samples of the material were collected. The material condition of each TSI material was assessed as described in the table below.

Material Condition Descriptions	
Condition	Description
No Damage	Material is intact and is not damaged
Damaged	Less than 10% distributed damage, or less than 25% localized damage
Significant Damage	10% or more distributed damage, or 25% or more localized damage

For each suspect homogeneous material, the homogeneous material number, material type, material description, location(s), approximate quantity of asbestos, friability, condition, sample identification, sample location, and sample result information were recorded on the sample summary tables found in Appendix B. The definition of a friable material is one that can be crushed, pulverized, or reduced to powder under hand pressure when dry. The definition of a nonfriable material is one that cannot be crushed, pulverized, or reduced to powder under hand pressure when dry.

Table 1 provides a summary of materials that tested positive for ACM in each building. Appendix B provides a floor plan and a summary of the materials and

locations sampled for asbestos in each building. Select photographs of materials that tested positive for asbestos (Photographs 1 and 2) are provided in Appendix C.

2.2 Laboratory Certifications and Sample Analysis

Bulk samples of suspect TSI ACM were analyzed by EHS of Richmond, VA using polarized light microscopy (PLM) with dispersion staining in accordance with laboratory methods USEPA/600/R-93/116 and USEPA/600/M4-82-020. EHS is a Pennsylvania Department of Environmental Protection (PADEP) National Environmental Laboratory Accreditation Program (NELAP) accredited laboratory for solid and chemical materials, including asbestos. Relevant EHS accreditations are included in Appendix A.

As per USEPA, a material is considered to be asbestos-containing when it contains 1 percent or more of asbestos. It should be noted that the “positive stop” approach was requested and implemented during this project. Using this approach, when the laboratory identifies a material as asbestos-containing, other samples of the same material/homogeneous area are not analyzed, under the assumption that those materials are also asbestos-containing. The laboratory report and chain-of-custody (COC) forms are provided in Appendix D.

2.3 Areas of Concern and Recommendations

The analytical results provided by EHS indicate a positive level of asbestos in two building materials within two homogeneous areas located in the Department of Health and Welfare Mechanical Room. The first material (HA-3A), identified as a grey 12-inch pipe elbow (Photograph 1), was reported as 4-percent chrysotile asbestos. This material (approximately 1 linear foot) is limited to the pipe elbow and was not observed elsewhere throughout the property. Additionally, asbestos was reported within HA-4A. This material was identified as a grey 16-inch pipe joint (Photograph 2) and was reported as 4-percent chrysotile asbestos. This material (approximately 1.5 linear feet) is limited to the pipe joint and was not observed elsewhere throughout the property.

It should be noted that HA-3B and -3C and HA-4B and -4C were not analyzed due to the laboratory’s positive stop protocol but should also be treated as ACM. Recommendations for the proper handling and disposal of this material are provided below. All other bulk samples collected by Rhea were reported as non-detect for asbestos.

It is assumed that the grey 12-inch pipe elbow (HA-3A) and grey 16-inch pipe joint (HA-4A) will be disturbed during demolition activities; therefore, handling and

disposal of ACM should be carried out in accordance with appropriate NESHAP guidelines prior to demolition activities (40 CFR Part 61, Subpart M).

NESHAP guidelines generally state that asbestos-containing waste should be sealed in a leak-tight container while wet, labeled, and disposed of properly in a landfill qualified to receive asbestos waste. In addition, transportation vehicles that move the waste from the point of generation to the asbestos landfill must meet approved labeling requirements and maintain appropriate waste shipment manifests. It should be noted that NESHAP does not require regulated ACM to be removed before demolition/renovation activities if the amount is less than 260 linear feet, 160 square feet, or 35 cubic feet; however, it is the industry standard to satisfactorily remove all identified friable ACM, in accordance with all applicable Federal, State and local laws and regulations.

As a result, asbestos abatement specifications and cost estimate have been developed by Gary Case of Michael Baker International for the safe removal of the positively identified ACM listed in Table 1. Gary Case is a USEPA certified Building Inspector, Management Planner, and Project Designer for asbestos. The purpose of the asbestos abatement specifications is to provide the abatement contractor with the minimum requirements and constraints to facilitate the satisfactory execution of asbestos abatement. The project cost estimate includes total cost pertaining to the required documents/submittals (as per specifications), mobilization and demobilization from the Site, and the abatement, waste management, transportation, and disposal of the two identified positive ACM samples. The total cost estimate for the abatement of the positively identified ACM is \$1,500.00, to be completed in one 8-hour work day. The asbestos abatement specifications and cost estimate were provided to GPI under separate cover.

3.0 LEAD-BASED PAINT SURVEY

3.1 Suspect Materials Sampled

Based upon the areas to be disturbed, as identified by GPI, LBP and/or LCP readings were collected from the North, Health & Welfare, Museum, South, and Forum buildings. LBP and/or LCP readings were not collected from the remaining buildings as no painted surfaces are planned to be disturbed during renovation activities in these buildings. A portable XRF analyzer was used to determine the presence of LBP. The XRF is a commonly used inspection method because it provides real-time results, is economical to use, and sampling does not disturb the painted surface. Using the XRF, Rhea was able to accurately identify building components containing LBP and LCP. During this investigation, a total of six XRF readings were collected on suspect painted materials. It should be noted that no physical paint chip samples or dust wipes were collected and submitted for laboratory analysis.

Based on the results of the XRF analysis, 2 of the 6 surfaces analyzed contained detectable concentrations of lead, which classifies the surfaces as LCP under OSHA Standard 29 CFR 1926.62. Per USEPA standards, none of the tested components are considered LBP. A listing of all XRF readings collected is provided in Table 2. Appendix B provides applicable floor plans. A photograph of the LCP surfaces (Photograph 3) is provided in Appendix C.

3.2 Areas of Concern and Recommendations

In summary, LCP was identified in the North building utility tunnel on the green cinder block wall and the red metal pipe (Table 2). The remaining readings were non-detect for LBP and LCP.

When building materials containing LBP or LCP are disturbed during demolition activities, harmful dust could be generated. For this reason, demolition contractors should be informed of the presence of LBP or LCP and proper use of personal protective equipment (PPE) should be implemented. OSHA standard 29 CFR 1926.62, Subpart D (Employee Safety and Health Regulations for Construction) should be implemented and understood prior to demolition activities. Additionally, to ensure that components containing LBP or LCP are properly tested and disposed of following demolition activities, USEPA's Resource Conservation and Recovery Act (RCRA) Hazardous Waste Disposal regulation 40 CFR 260–268 should be implemented and understood prior to demolition activities.

4.0 LIMITATIONS

The content of this report, including professional interpretation and evaluation of existing site conditions, is based entirely on the available information gathered. The gathered information is limited by its availability from public resources and the scope, budget, and project schedule. Methods used to assemble information contained in this report are consistent with commercially acceptable practices. The methods are not intended to be exhaustive in nature and in no way guarantee that a site is free from environmental risk.

Rhea conducts building surveys in general accordance with accepted professional practices as applied by similar professionals. Inspection results for each survey are considered sufficient in detail and scope to identify accessible and/or exposed LBP and ACM, which were present in the facility at the time of the inspection. Although every effort was made to identify all potential hazardous materials, there is no guarantee that additional materials are not present. Conditions may exist within a facility which may prevent the inspector from identifying hazardous materials, which may only become apparent during demolition activities. Laboratory results for each sample are valid only for the materials tested.

Material descriptions, locations, and approximate quantities are intended for informational purposes for Rhea clients only. Rhea assumes no responsibility or liability arising from claims involving contract disputes for unauthorized use of this information.

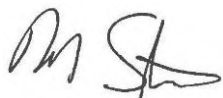
Conclusions and recommendations provided in this report are intended to be used as guidance materials for the benefit of Rhea clients only. Information in this report should not be construed as legal advice, nor be used for the purpose of advertising, sales, or other publicity-related purposes.

5.0 PREPARER QUALIFICATIONS

Mr. Michael Stoehr, Assistant Project Manager and Geologist II, led the Hazardous Materials Survey, reviewed site documentation, and participated in the completion of the report. Mr. Stoehr is a registered PA Asbestos Inspector (#056261). He holds a Bachelor of Science degree in Geology and a Master of Science degree in Geo-Environmental Studies and has approximately 7 years of experience in various environmental investigations including, but not limited to asbestos investigations, Phase I and Phase II ESAs, environmental baseline studies, site characterizations, and technical report writing and review.

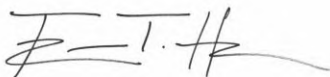
Mr. Erik Hartle, Geologic Specialist I, conducted the Hazardous Materials Survey, gathered and reviewed background information, worked with the analytical laboratory, and assisted with the preparation of the Hazardous Materials Survey Report under the supervision of Mr. Stoehr. Mr. Hartle is a registered PA Asbestos Inspector (#063208). He holds a Bachelor of Science degree in Geology and has over six years of experience in asbestos and hazardous material investigations, AST and UST inspections, erosion and sediment control inspections, long-term monitoring, wetland investigations, and technical report writing.

Copies of applicable PA Asbestos Inspector licenses for Mr. Stoehr and Mr. Hartle are included in Appendix A.



Michael R. Stoehr, PG
Registered PA Asbestos Inspector (#056261)

Date: 7/12/2023



Erik T. Hartle
Registered PA Asbestos Inspector (#063208)

Date: 7/12/2023

6.0 REFERENCES

OSHA, CFR, Title 29, Part 1926.1101 (Asbestos)

OSHA, CFR, Title 29, Part 1926.62, Subpart D. *Employee Safety and Health Regulations for Construction*.

USEPA, CFR, Title 40, Part 61, Subpart M, 1990. *National Emissions Standards for Hazardous Air Pollutants*. November.

USEPA, CFR, Title 40, Part 745, Subpart L, 1996. *Lead-Based Paint Activities*. August 1996.

USEPA, CFR, Title 40, Part 260-268. *RCRA Hazardous Waste Disposal Regulations*

TABLES

TABLE 1**ACM SUMMARY OF DETECTIONS****Department of Labor & Industry - 651 Boas Street**

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

Department of Health & Welfare - 625 Forster Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
3	Department of Health and Welfatre	Thermal Systems Insulation	Grey 12-inch pipe elbow	4% Chrysotile	Friable	1 LF	No Damage
4	Department of Health and Welfatre	Thermal Systems Insulation	Grey 16-inch pipe joint	4% Chrysotile	Friable	1.5 LF	Damaged

Finance Building - 129 Finance Building

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

TABLE 1

ACM SUMMARY OF DETECTIONS

North Office Building - 401 North Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

Capitol East Wing - Commonwealth Avenue

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

Main Capitol Bulding - 501 N 3rd Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

TABLE 1

ACM SUMMARY OF DETECTIONS

Museum - 300 North Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

Speaker Matthew J. Ryan Building - 451 N 3rd Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

South Office Building - Commonwealth Avenue

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

Forum Auditorium - 500 Walnut Street

Homogeneous Material Number	Building Name	Material Type	Material Description	Sample Results	Category of ACM	Approximate Quantity of Asbestos	Condition of Material
No asbestos detected							

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHA, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.

Parcel(s)	Owner	Address	Type	Age
29.1	Huffman	121 Wolfe Run Road	Single Family Home	1950s
29.6	Wolfe	189 Wolfe Run Road	Trailer	1975
			Well House	Unknown
			Storage Building	Unknown
29.7	Laurita	Wolfe Run Road	Land Only	N/A
30	Myers	Wolfe Run Road	Dilapidated Garage	Unknown
			Ruins of Foundation	Unknown
21.2, 24, 25	MCDA	295 Wolfe Run Road	Split Entry Home	2002
			Detached Garage*	Unknown
			Dilapidated Home	Unknown
			Gun Range Structure(s)*	Unknown
			Storage Building	Unknown
			1 Movable Shed	Unknown
21.3, 29.2	Lazelle	211 Wolfe Run Road	Trailer**	2005
			Detached Garage	Unknown
29.3, 29.4, 29.5	Lazelle	171 Wolfe Run Road	Doublewide Trailer**	1994
			Garage	Unknown
			Carport	Unknown
			Outbuilding	Unknown

Notes:

*Structures are not being demolished and are not to be part of this investigation.

**Structures are being removed by property owners and are not to be part of this investigation.

TABLE 2
XRF RESULTS SUMMARY TABLE

Date: 6/22/23 to 6/23/23

Client:

Greenman-Pedersen, Inc.

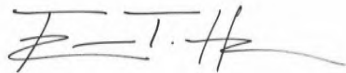
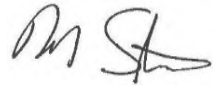
Site/Building ID:

Harrisburg Capitol Complex - North, Health & Welfare, Museum, South, and Forum

Inspector(s):

Mike Stoehr / Erik Hartle

Signature(s):



READING	LOCATION	ROOM	COMPONENT	SUBSTRATE	PAINT CONDITION	COLOR	NOTES	LBP RESULT	LBP CONCENTRATION	UNIT	DATE OF READING
1	North Tunnel	Utility Tunnel	Wall	Cinder Block	Good	Green		LCP	<0.1	mg/cm ²	6/22/2023
2			Pipe	Metal	Good	Red		LCP	0.2	mg/cm ²	6/22/2023
3	Health & Welfare	Mechanical Room	Wall	Plaster	Damaged	Green		ND	0.0	mg/cm ²	6/23/2023
4	Museum	Mechanical Room	Wall	Concrete	Good	White		ND	0.0	mg/cm ²	6/23/2023
5	South	Mechanical Room	Wall	Concrete	Good	Green		ND	0.0	mg/cm ²	6/23/2023
6	Forum	Mechanical Room	Wall	Concrete	Good	Grey		ND	0.0	mg/cm ²	6/23/2023

Notes:

Red, shaded cells indicate a positive detection of LBP (greater than 0 and 1 mg/cm²) per USEPA and OSHA Standards

Gray, shaded cells indicate a positive detection of LCP (greater than 0 mg/cm²) per OSHA Standard

mg/cm² = milligrams per square centimeter

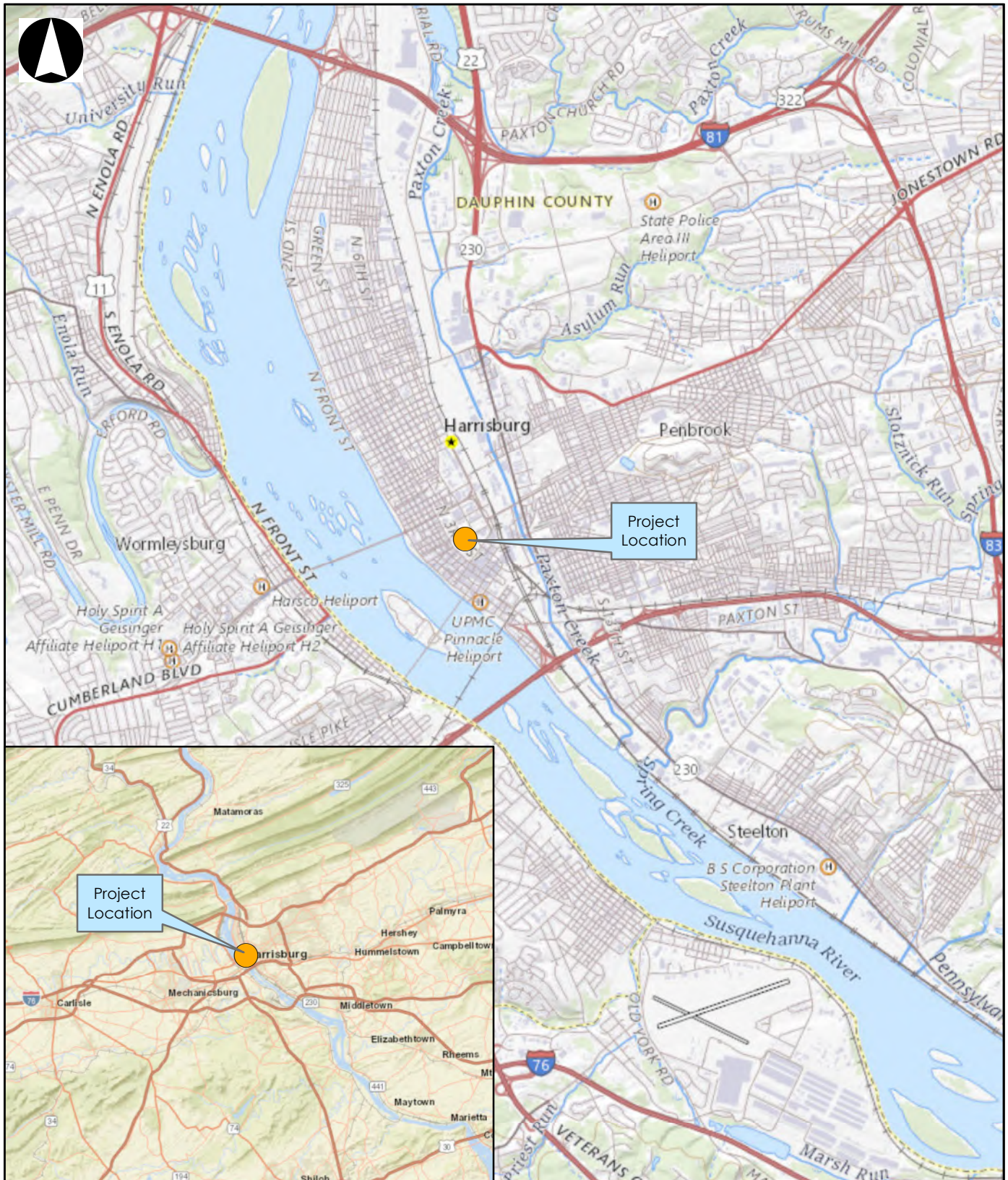
NA = Not Applicable

ND = Not Detected

LBP = Lead-Based Paint

LCP = Lead-Containing Paint

FIGURES



Legend

 Project Location



0 4,250 8,500 Feet

FIGURE 1

**Project Location Map
Hazardous Materials Survey
Harrisburg Capitol Complex
Harrisburg, PA**

Drawn By	Checked By	Date	Project	Sheet No.
MRS	ZDW	6/19/23	2430	1



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

 Site Buildings



FIGURE 2

**Site Layout Map
Hazardous Materials Survey
Harrisburg Capitol Complex
Harrisburg, PA**

Drawn By	Checked By	Date	Project	Sheet No.
MRS	ZDW	6/19/23	2430	2

APPENDIX A

Professional Certifications and Accreditations

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF LABORATORIES

LABORATORY ACCREDITATION PROGRAM

Certifies That

68-01497

Environmental Hazards Services LLC

7469 Whitepine Road, North Chesterfield, VA, 23237-2261

Having duly met the requirement of

The act of June 29, 2002 (P.L. 596, No. 90)

dealing with Environmental Laboratories Accreditation

(27 Pa. C.S. 4104-4113) and the

National Environmental Laboratory Accreditation Program Standard

is hereby approved as an

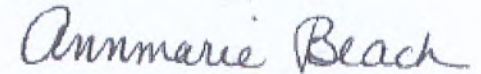
Accredited Laboratory

to conduct analysis within the fields of accreditations more fully described in the attached Scope of Accreditation

NELAP accreditation granted by the PA DEP to an environmental laboratory is conditioned upon continued compliance with the current edition of the NELAC Standard or TNI Standard and the following Subchapters and Sections of 25 Pa. Code Chapter 252: Subchapter A (relating to general provisions); Subchapter B (relating to application, fees and supporting documents); Subchapter E (relating to proficiency test study requirements); Subchapter F (relating to assessment requirements); Subchapter G (relating to miscellaneous provisions); Section 252.307; and Section 252.401.

Expiration Date: **01/31/2024**

Certificate Number: **015**



Annmarie Beach, Chief
Laboratory Accreditation Program
Bureau of Laboratories



Continued accreditation status depends on successful ongoing participation in the program
Certificate not transferable Surrender upon revocation
To be conspicuously displayed at the Laboratory
Not valid unless accompanied by a valid Scope of Accreditation
Shall not be used to imply endorsement by the Commonwealth of Pennsylvania
Customers are urged to verify the laboratory's current accreditation status
PA DEP is a NELAP recognized accreditation body

Laboratory Scope of Accreditation



Attached to Certificate of Accreditation 015-001 expiration date 01/31/2024. This listing of accredited analytes should be used only when associated with a valid certificate of accreditation.

Environmental Hazards Services LLC
7469 Whitepine Road
North Chesterfield, VA 23237-2261
(804) 275-4788

DEP Laboratory ID: 68-01497
EPA Lab Code: VA01122
TNI Code: TNI01759

Matrix: Solid and Chemical Materials

Method	Revision	TNI Method Code	Analyte	TNI Analyte Code	Accreditation Type	Primary State	Effective Date
EPA 1311		10118806	Toxicity characteristic leaching procedure (TCLP)	1466	NELAP	VA	01/13/2012
EPA 3010	A	10133605	Hot plate acid digestion (HNO ₃ + HCl)	1420	NELAP	VA	01/13/2012
EPA 3050	B	10135601	Acid digestion of solids	1400	NELAP	VA	01/13/2012
EPA 600/R-93/116		10294583	Asbestos	1520	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Aluminum	1000	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Antimony	1005	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Arsenic	1010	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Barium	1015	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Beryllium	1020	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Cadmium	1030	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Chromium	1040	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Cobalt	1050	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Copper	1055	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Iron	1070	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Lead	1075	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Magnesium	1085	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Manganese	1090	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Molybdenum	1100	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Nickel	1105	NELAP	VA	01/20/2016
EPA 6010	D	10155950	Selenium	1140	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Silver	1150	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Thallium	1165	NELAP	VA	01/13/2012

Annmarie Beach

The Pennsylvania Department of Environmental Protection Laboratory Accreditation Program is a NELAP recognized Accreditation Body. Customers are urged to verify the laboratory's current accreditation standing.

Laboratory Scope of Accreditation



Attached to Certificate of Accreditation 015-001 expiration date 01/31/2024. This listing of accredited analytes should be used only when associated with a valid certificate of accreditation.

Environmental Hazards Services LLC
7469 Whitepine Road
North Chesterfield, VA 23237-2261
(804) 275-4788

DEP Laboratory ID: 68-01497
EPA Lab Code: VA01122
TNI Code: TNI01759

Matrix: Solid and Chemical Materials

Method	Revision	TNI Method Code	Analyte	TNI Analyte Code	Accreditation Type	Primary State	Effective Date
EPA 6010	D	10155950	Titanium	1180	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Vanadium	1185	NELAP	VA	01/13/2012
EPA 6010	D	10155950	Zinc	1190	NELAP	VA	01/13/2012
EPA 7000	B	10157707	Lead	1075	NELAP	VA	01/13/2012
EPA 7471	B	10166457	Mercury	1095	NELAP	VA	01/13/2012

Annmarie Beach

The Pennsylvania Department of Environmental Protection Laboratory Accreditation Program is a NELAP recognized Accreditation Body. Customers are urged to verify the laboratory's current accreditation standing.

PENNSYLVANIA ASBESTOS CERTIFICATION

063208

Birth Date
08/12/1991



ERIK T HARTLE
C/O RHEA ENGINEERS
441 MARS VALENCIA RD
VALENCIA PA 16059

Expires
10/06/2023

Issue Date
10/17/2022

Sex
M

Height
5' 06"

Eyes
HZL

A handwritten signature in black ink, appearing to read "Erik T Hartle", followed by a horizontal line.

Class
INSPECTOR

PENNSYLVANIA ASBESTOS CERTIFICATION



056261

Birth Date
09/28/1990

MICHAEL R STOEHR
1214 ARROWOOD DRIVE
PITTSBURGH PA 15243

Expires
10/06/2023

Issue Date
10/17/2022

Sex
M

Height
6' 02"

Eyes
HZL

Class
INSPECTOR

MS

APPENDIX B

Hazardous Material Summaries

APPENDIX B1

Department of Labor & Industry

ASBESTOS SURVEY MATERIAL SUMMARY

DEPARTMENT OF LABOR AND INDUSTRY
651 BOAS STREET

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

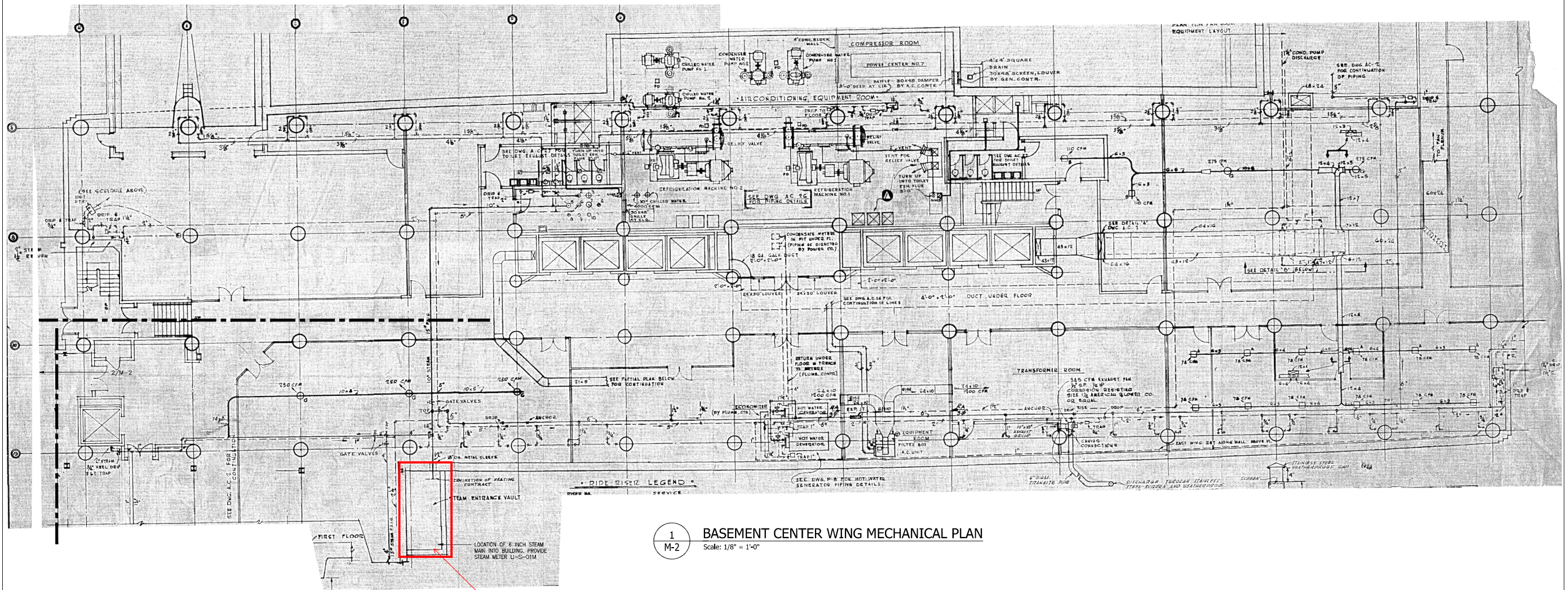
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
6	Thermal Systems Insulation	White 12-inch pipe elbow	L&I Mechanical Room	Yes	HA-6A HA-6B HA-6C	NAD	L&I Mechanical Room	No	N/A	N/A
7	Thermal Systems Insulation	White 12-inch pipe wrap	L&I Mechanical Room	Yes	HA-7A HA-7B HA-7C	NAD	L&I Mechanical Room	No	N/A	N/A
8	Thermal Systems Insulation	White 10-inch pipe elbow	L&I Mechanical Room	Yes	HA-8A HA-8B HA-8C	NAD	L&I Mechanical Room	No	N/A	N/A
9	Thermal Systems Insulation	White 10-inch pipe wrap	L&I Mechanical Room	Yes	HA-9A HA-9B HA-9C	NAD	L&I Mechanical Room	No	N/A	N/A

Notes:

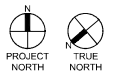
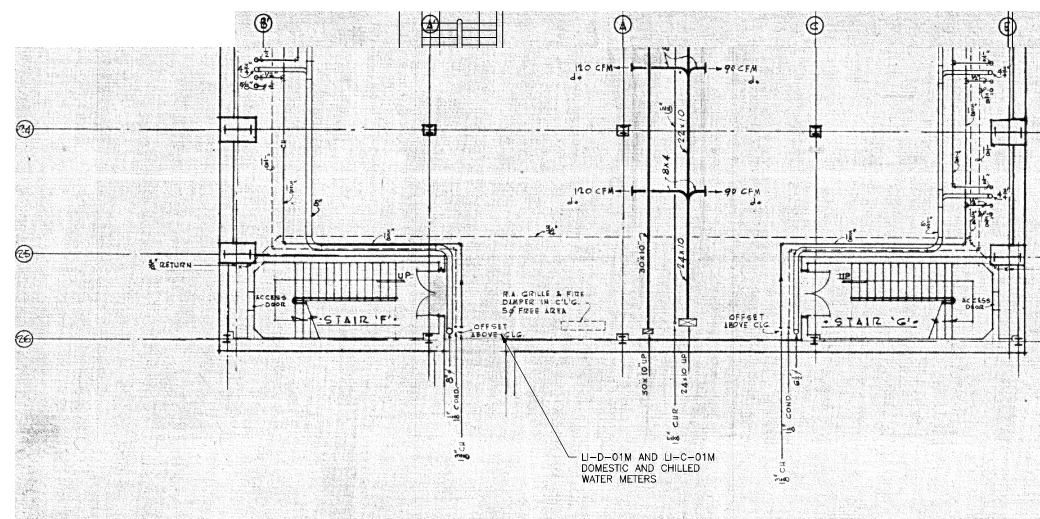
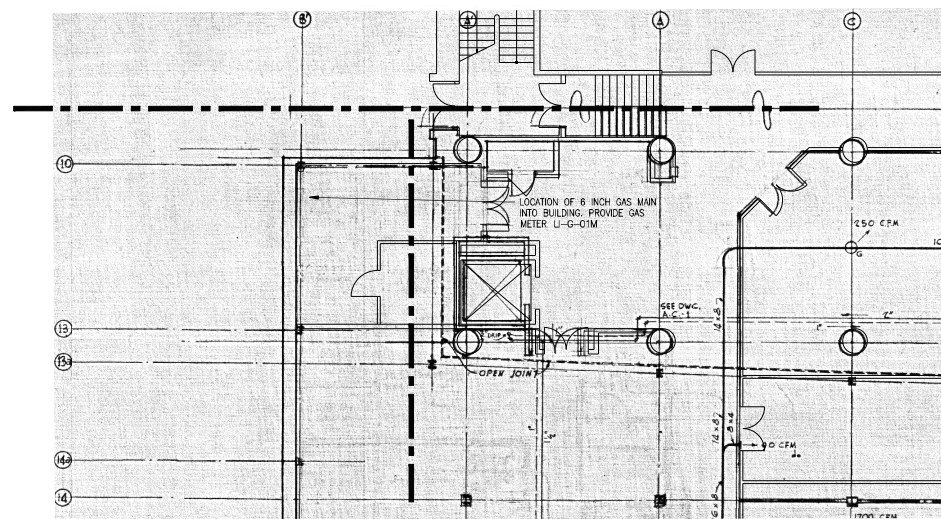
NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.



steam pipe in this space
requires investigation



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE -
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

LABOR AND INDUSTRY BUILDING MECHANICAL PLAN

VERIFY SCALE
BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING.
0 1
IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY.
CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
DATE
01/17/23
CHECKED BY
M. RADZICKI
SCALE
AS NOTED
DRAWING No.
M-2

APPENDIX B2

Department of Health & Welfare

ASBESTOS SURVEY MATERIAL SUMMARY

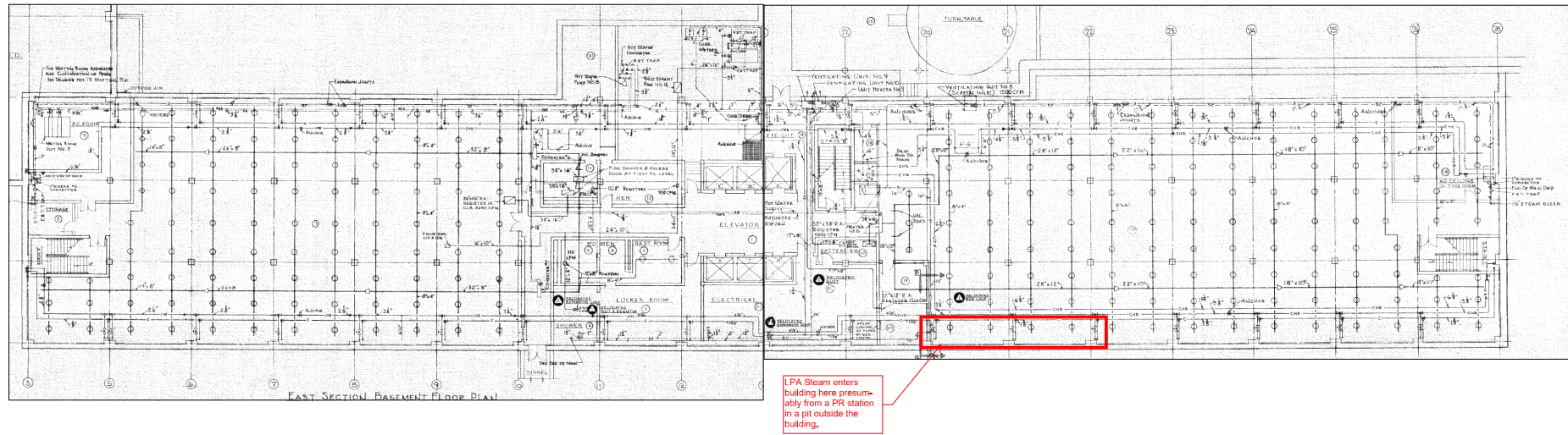
**DEPARTMENT OF HEALTH AND WELFARE
625 FORSTER STREET**

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
3	Thermal Systems Insulation	Grey 12-inch pipe elbow	H&W Mechanical Room	Yes	HA-3A	4% Chrysotile	H&W Mechanical Room	Yes	1 LF	No Damage
					HA-3B	Not Analyzed				
					HA-3C	Not Analyzed				
4	Thermal Systems Insulation	Grey 16-inch pipe joint	H&W Mechanical Room	Yes	HA-4A	4% Chrysotile	H&W Mechanical Room	Yes	1.5 LF	Damaged
					HA-4B	Not Analyzed				
					HA-4C	Not Analyzed				
5	Thermal Systems Insulation	White 12-inch pipe elbow	H&W Mechanical Room	Yes	HA-5A	NAD	H&W Mechanical Room	No	N/A	N/A
					HA-5B					

NAD = No Asbestos Detected

N/A = Not Applicable

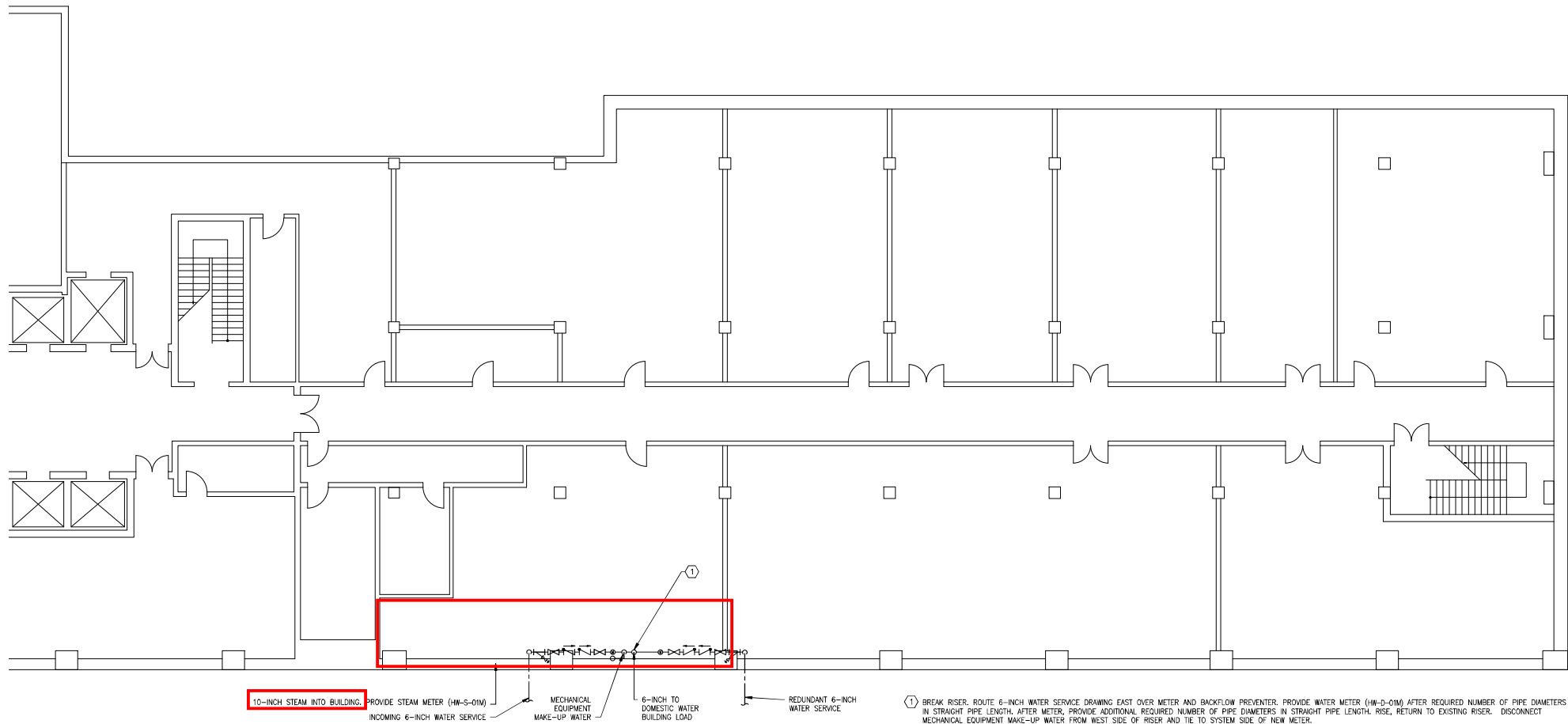


LPA Steam enters building here presumably from a PR station in a pit outside the building.

1 BASEMENT OVERALL PLAN
Scale: 1/16" = 1'-0"



3 DOMESTIC WATER SERVICE ENTRANCE
Scale: 1/8" = 1'-0"



10-INCH STEAM INTO BUILDING. PROVIDE STEAM METER (HM-S-01M) INCOMING 6-INCH WATER SERVICE. MECHANICAL EQUIPMENT MAKE-UP WATER. 6-INCH TO DOMESTIC WATER BUILDING LOAD. REDUNDANT 6-INCH WATER SERVICE.

① BREAK RISER. ROUTE 6-INCH WATER SERVICE DRAWING EAST OVER METER AND BACKFLOW PREVENTER. PROVIDE WATER METER (HM-D-01M) AFTER REQUIRED NUMBER OF PIPE DIAMETERS IN STRAIGHT PIPE LENGTH. AFTER METER, PROVIDE ADDITIONAL REQUIRED NUMBER OF PIPE DIAMETERS IN STRAIGHT PIPE LENGTH. RISE, RETURN TO EXISTING RISER. DISCONNECT MECHANICAL EQUIPMENT MAKE-UP WATER FROM WEST SIDE OF RISER AND TIE TO SYSTEM SIDE OF NEW METER.

2 BASEMENT MECHANICAL PART PLAN
Scale: 1/8" = 1'-0"



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No. C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE –
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

HEALTH & WELFARE BUILDING MECHANICAL PLAN

VERIFY SCALE
BAR IS ONE (1) INCH LONG ON ORIGINAL DRAWING.
0 1
IF BAR IS NOT ONE (1) INCH LONG, ADJUST SCALE ACCORDINGLY.
CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS. VARIANCE FROM CONTRACT DOCUMENTS NOT PERMITTED WITHOUT PROFESSIONAL & BUREAU OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI

DATE
01/17/23

DRAWING No.
M-3

CHECKED BY
M. RADZICKI

SCALE
AS NOTED

APPENDIX B3

Finance Building

ASBESTOS SURVEY MATERIAL SUMMARY

FINANCE BUILDING 129 FINANCE BUILDING HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

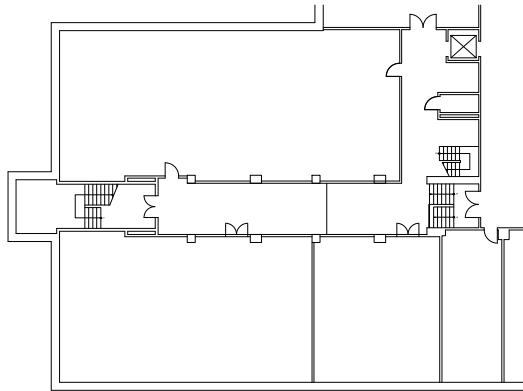
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
16	Thermal Systems Insulation	White 12-inch pipe wrap	Finance Mechanical Room	Yes	HA-16A	NAD	Finance Mechanical Room	No	N/A	N/A
					HA-16B					
					HA-16C					
17	Thermal Systems Insulation	White 8-inch pipe wrap	Finance Mechanical Room	Yes	HA-17A	NAD	Finance Mechanical Room	No	N/A	N/A
					HA-17B					
					HA-17C					

Notes:

NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.

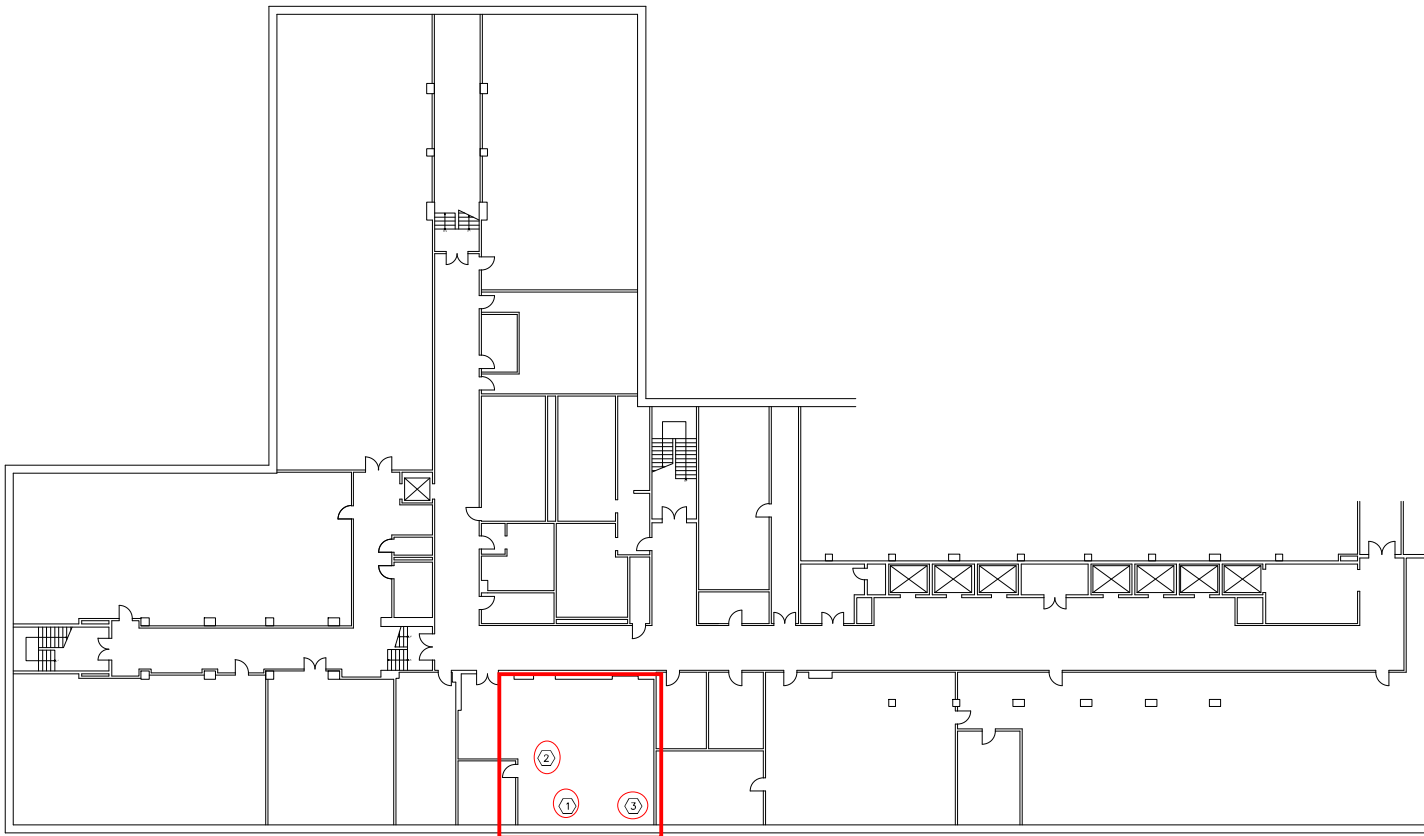


- ① PROVIDE STEAM METER (FI-S-01M). BREAK PIPE AT ENTRANCE TO THE BUILDING. ROUTE ACROSS CEILING. INSTALL METER. ROUTE SUFFICIENT LENGTH OF STRAIGHT PIPE AFTER METER. DOUBLE BACK AND RECONNECT TO EXISTING RISER.
- ② PROVIDE CHILLED WATER METER FI-C-01M
- ③ PROVIDE DOMESTIC WATER METER FI-D-01M

2
M-5

PARTIAL TERRACE LEVEL MECHANICAL PLAN

Scale: 1/16" = 1'-0"

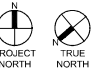


there are a lot of haz-
mat labels on items in
this room

1
M-5

BASEMENT MECHANICAL PLAN

Scale: 1/16" = 1'-0"



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC

52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE -
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

FINANCE BUILDING MECHANICAL PLAN

VERIFY SCALE

BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING.

0 1

IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY

CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI

DATE
01/17/23

DRAWING No.

M-5

CHECKED BY
M. RADZICKI

SCALE
AS NOTED

APPENDIX B4

North Office Building

ASBESTOS SURVEY MATERIAL SUMMARY

NORTH OFFICE BUILDING 401 NORTH STREET

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

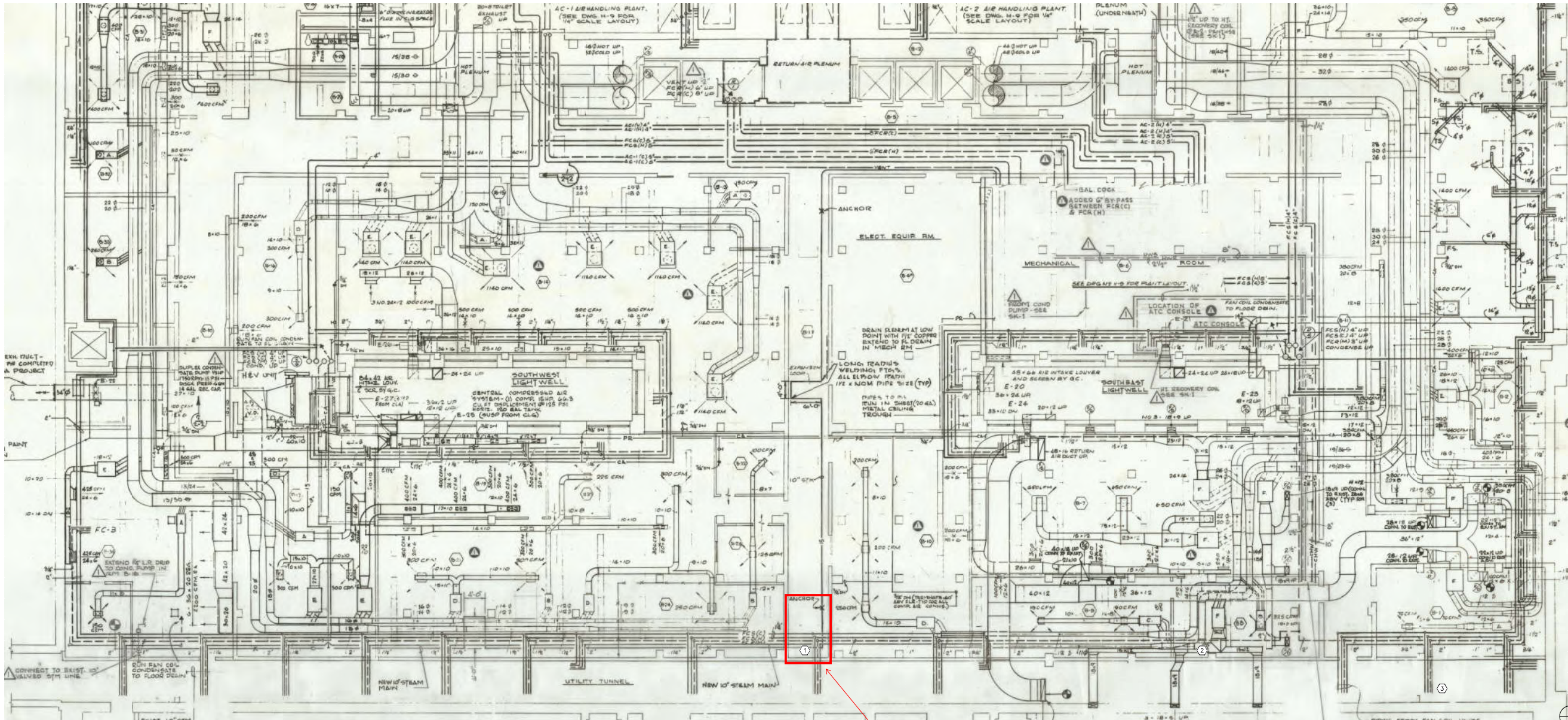
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
1	Thermal Systems Insulation	White 8-inch pipe wrap	North Utility Tunnel	Yes	HA-1A HA-1B HA-1C	NAD	North Utility Tunnel	No	N/A	N/A
2	Thermal Systems Insulation	White 8-inch pipe elbow	North Utility Tunnel	Yes	HA-2A HA-2B HA-2C	NAD	North Utility Tunnel	No	N/A	N/A

Notes:

NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.



1
M-8
BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"

this space houses the steam service entrance to the building. It requires investigation.

SHEET KEYNOTES

- 1 PROVIDE STEAM METER (NO-S-01M). BREAK PIPE AT ENTRANCE TO THE BUILDING. ROUTE ACROSS CEILING. INSTALL METER. ROUTE SUFFICIENT LENGTH OF STRAIGHT PIPE AFTER METER, DOUBLE BACK AND RECONNECT TO EXISTING RISER.
- 2 PROVIDE CHILLED WATER METER NO-C-01M
- 3 PROVIDE DOMESTIC WATER METER NO-D-01M

PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMORA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE –
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA
NORTH OFFICE BUILDING MECHANICAL PLAN

VERIFY SCALE
BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING.
0 1
IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY.
CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
DATE
01/17/23
DRAWING No.
M-8
CHECKED BY
M. RADZICKI
SCALE
AS NOTED

APPENDIX B5

Capitol East Wing

ASBESTOS SURVEY MATERIAL SUMMARY

CAPITOL EAST WING COMMONWEALTH AVENUE HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

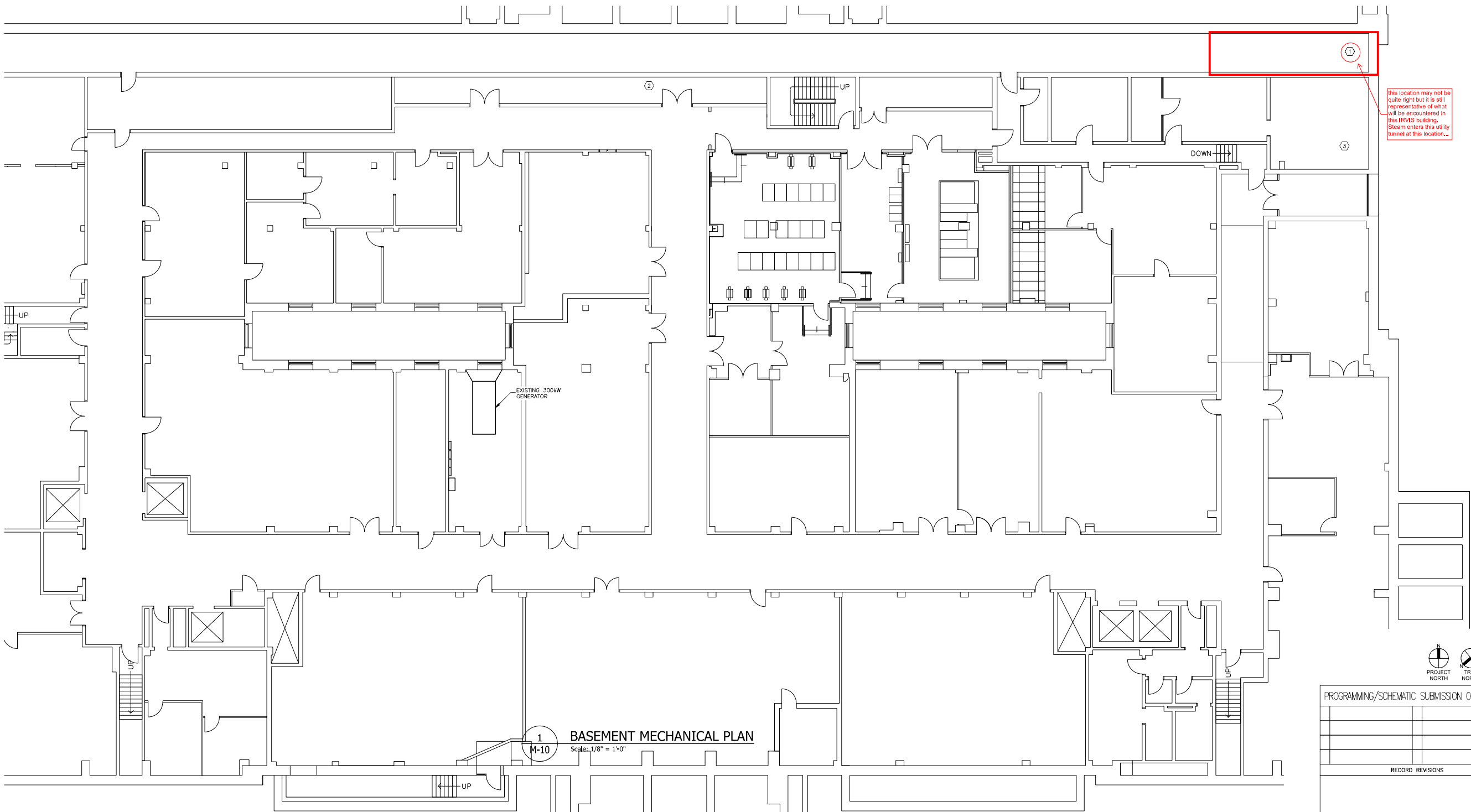
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
11	Thermal Systems Insulation	White 12-inch pipe wrap	East Capitol Mechanical Room	Yes	HA-11A HA-11B HA-11C	NAD	East Capitol Mechanical Room	No	N/A	N/A

Notes:

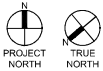
NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.



this location may not be quite right but it is still representative of what will be encountered in this IRVIS building. Steam enters this utility tunnel at this location.



- ① PROVIDE STEAM METER (10-S-01M). BREAK PIPE AT ENTRANCE TO THE BUILDING. ROUTE ACROSS CEILING. INSTALL METER. ROUTE SUFFICIENT LENGTH OF STRAIGHT PIPE AFTER METER. DOUBLE BACK AND RECONNECT TO EXISTING RISER.
- ② PROVIDE CHILLED WATER METER 10-C-01M
- ③ PROVIDE DOMESTIC WATER METER 10-D-01M

1
M-10
BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"

PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE -
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

CAPITOL EAST WING MECHANICAL PLAN

VERIFY SCALE

BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING:

0 1

IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY

CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
CHECKED BY
M. RADZICKI

DATE
01/17/23
SCALE
AS NOTED

DRAWING No.
M-10

APPENDIX B6

Main Capitol Building

ASBESTOS SURVEY MATERIAL SUMMARY

MAIN CAPITOL BUILDING

501 N 3RD STREET

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

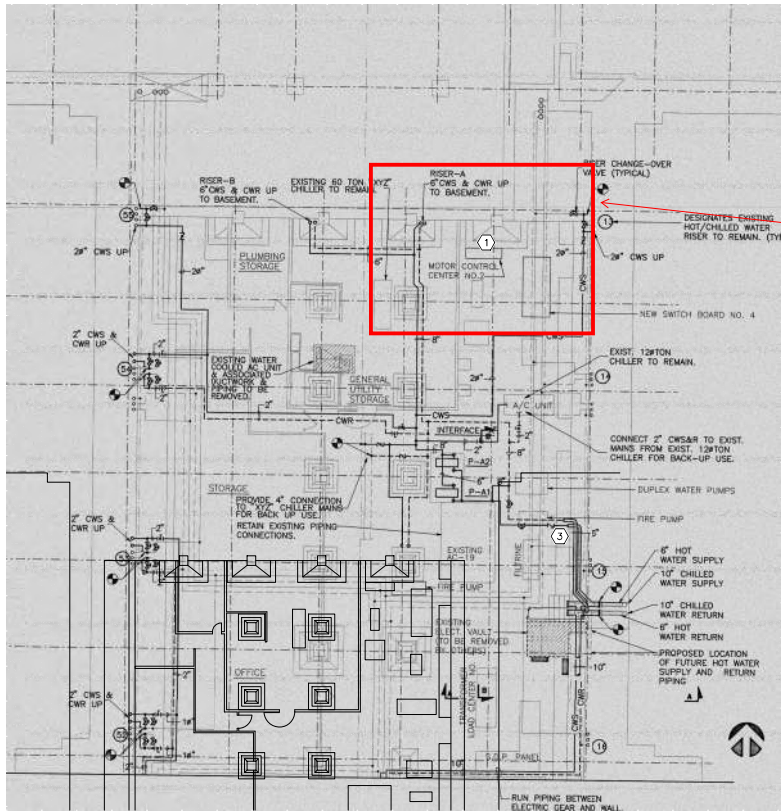
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
12	Thermal System Insulation	White 8-inch pipe wrap	Main Capitol Mechanical Room	Yes	HA-12A HA-12B HA-12C	NAD	Main Capitol Mechanical Room	No	N/A	N/A

Notes:

NAD = No Asbestos Detected

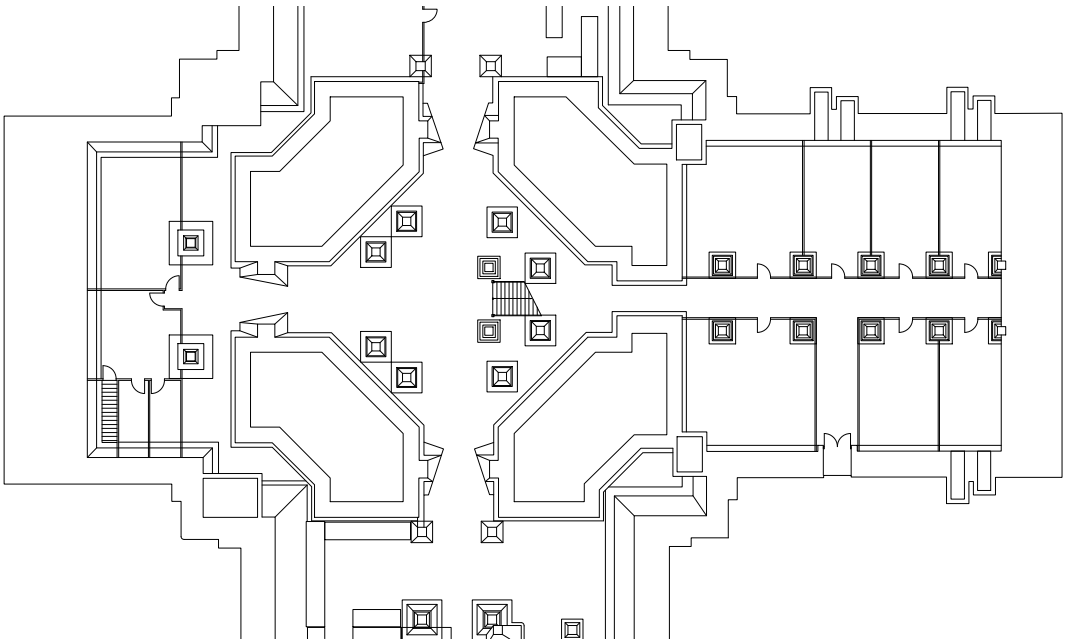
N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.

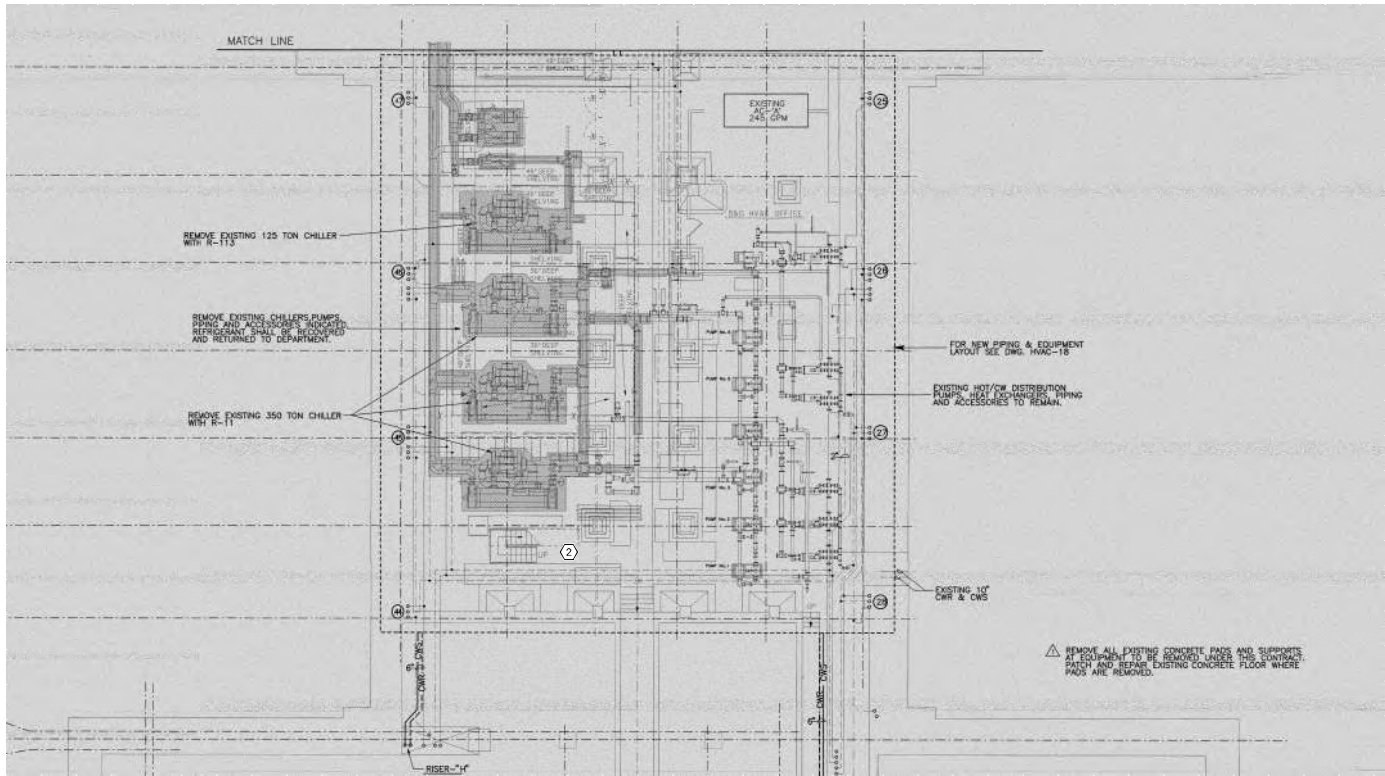


the steam
pressure
reducing
station is
located
here

1
M-11
SUB-BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"

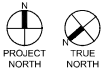


1
M-11
SUB-BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"



3
M-11
SUB-BASEMENT SOUTH MECHANICAL PLAN
Scale: 1/8" = 1'-0"

- 1 PROVIDE STEAM METER (MC-S-01M), BREAK PIPE OUTSIDE OF ROOM WITH PRESSURE REDUCING STATIONS. INSTALL METER, ROUTE SUFFICIENT LENGTH OF STRAIGHT PIPE AFTER METER EN ROUTE TO PRESSURE REDUCING STATIONS.
- 2 PROVIDE CHILLED WATER METER MC-C-01M
- 3 PROVIDE DOMESTIC WATER METER MC-D-01M



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE –
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

MAIN CAPITOL CENTER SUB-BASEMENT MECHANICAL PLAN

VERIFY SCALE
BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING.
0 1
IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY.
CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
DATE
01/17/23
DRAWING No.
M-11
CHECKED BY
M. RADZICKI
SCALE
AS NOTED

APPENDIX B7

Museum

ASBESTOS SURVEY MATERIAL SUMMARY

MUSEUM

300 NORTH STREET

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

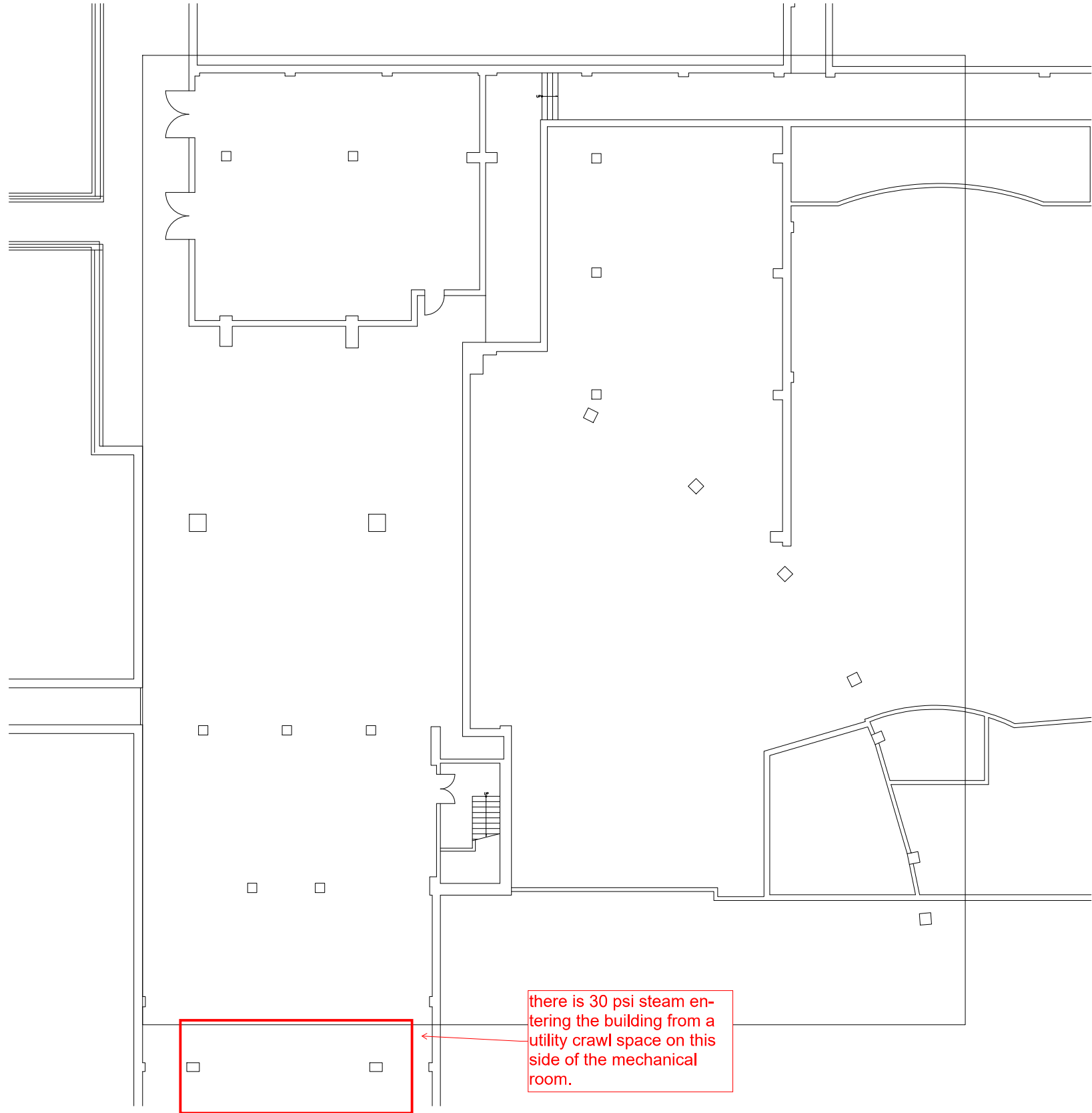
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
10	Thermal Systems Insulation	White 12-inch pipe wrap	Museum Mechanical Room	Yes	HA-10A HA-10B HA-10C	NAD	Museum Mechanical Room	No	N/A	N/A

Notes:

NAD = No Asbestos Detected

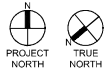
N/A = Not Applicable

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1
M-13
BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"

there is 30 psi steam entering the building from a utility crawl space on this side of the mechanical room.



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE -
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

PA STATE MUSEUM MECHANICAL PLAN

VERIFY SCALE

BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING:
0 1
IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY

CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
CHECKED BY
M. RADZICKI

DATE
01/17/23
SCALE
AS NOTED

DRAWING No.
M-13

APPENDIX B8

Speaker Matthew J. Ryan Building

ASBESTOS SURVEY MATERIAL SUMMARY

SPEAKER MATTHEW J. RYAN BUILDING

451 N 3RD STREET

HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

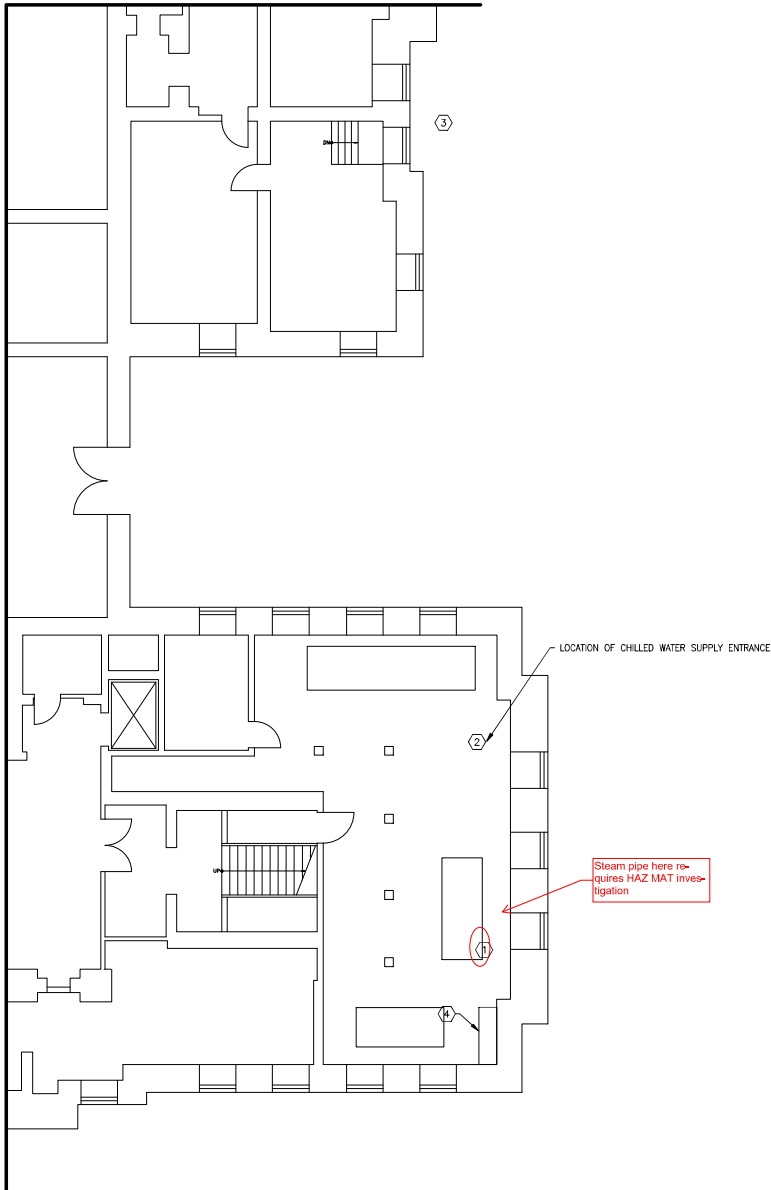
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
13	Thermal Systems Insulation	White 8-inch pipe wrap	Ryan Mechanical Room	Yes	HA-13A HA-13B HA-13C	NAD	Ryan Mechanical Room	No	N/A	N/A
14	Thermal Systems Insulation	White 8-inch pipe elbow	Ryan Mechanical Room	Yes	HA-14A HA-14B HA-14C	NAD	Ryan Mechanical Room	No	N/A	N/A

Notes:

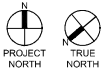
NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.



- ① PROVIDE STEAM METER (RY-S-01M). BREAK PIPE BEFORE PRESSURE REDUCTION. INSTALL METER. RECONNECT TO EXISTING STEAM PIPE.
- ② PROVIDE CHILLED WATER METER RY-C-01M.
- ③ PROVIDE DOMESTIC WATER METER RY-D-01M.
- ④ JOHNSON CONTROLS BMS CONTROL ENCLOSURE.



PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023

RECORD REVISIONS

SIGNATURE DATE SIGNATURE DATE

GREENMAN-PEDERSEN, INC
52 GLENMAURA NATIONAL BOULEVARD
SCRANTON, PENNSYLVANIA 18505

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
C-0948-0098 PHASE 1

AUTOMATION SYSTEM UPGRADE –
CAPITOL COMPLEX
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, DAUPHIN COUNTY, PA

RYAN BUILDING MECHANICAL PLAN

VERIFY SCALE

BAR IS ONE (1) INCH LONG
ON ORIGINAL DRAWING:
0 1
IF BAR IS NOT ONE (1) INCH LONG,
ADJUST SCALE ACCORDINGLY

CONTRACTOR SHALL FIELD VERIFY
ALL DIMENSIONS.
VARIANCE FROM CONTRACT
DOCUMENTS NOT PERMITTED
WITHOUT PROFESSIONAL & BUREAU
OF CONSTRUCTION APPROVAL.

DRAWN BY
M. SKORANSKI
CHECKED BY
M. RADZICKI

DATE
01/17/23
SCALE
AS NOTED

DRAWING No.

M-12

1
M-12
BASEMENT MECHANICAL PLAN
Scale: 1/8" = 1'-0"

APPENDIX B9

South Office Building

ASBESTOS SURVEY MATERIAL SUMMARY

SOUTH OFFICE BUILDING COMMONWEALTH AVENUE HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
15	Thermal Systems Insulation	White 12-inch pipe wrap	South Mechanical Room	Yes	HA-15A HA-15B HA-15C	NAD	South Mechanical Room	No	N/A	N/A

Notes:

NAD = No Asbestos Detected

N/A = Not Applicable

According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.

APPENDIX B10

Forum Auditorium

ASBESTOS SURVEY MATERIAL SUMMARY

FORUM AUDITORIUM 500 WALNUT STREET HARRISBURG CAPITOL COMPLEX HAZARDOUS MATERIALS SURVEY

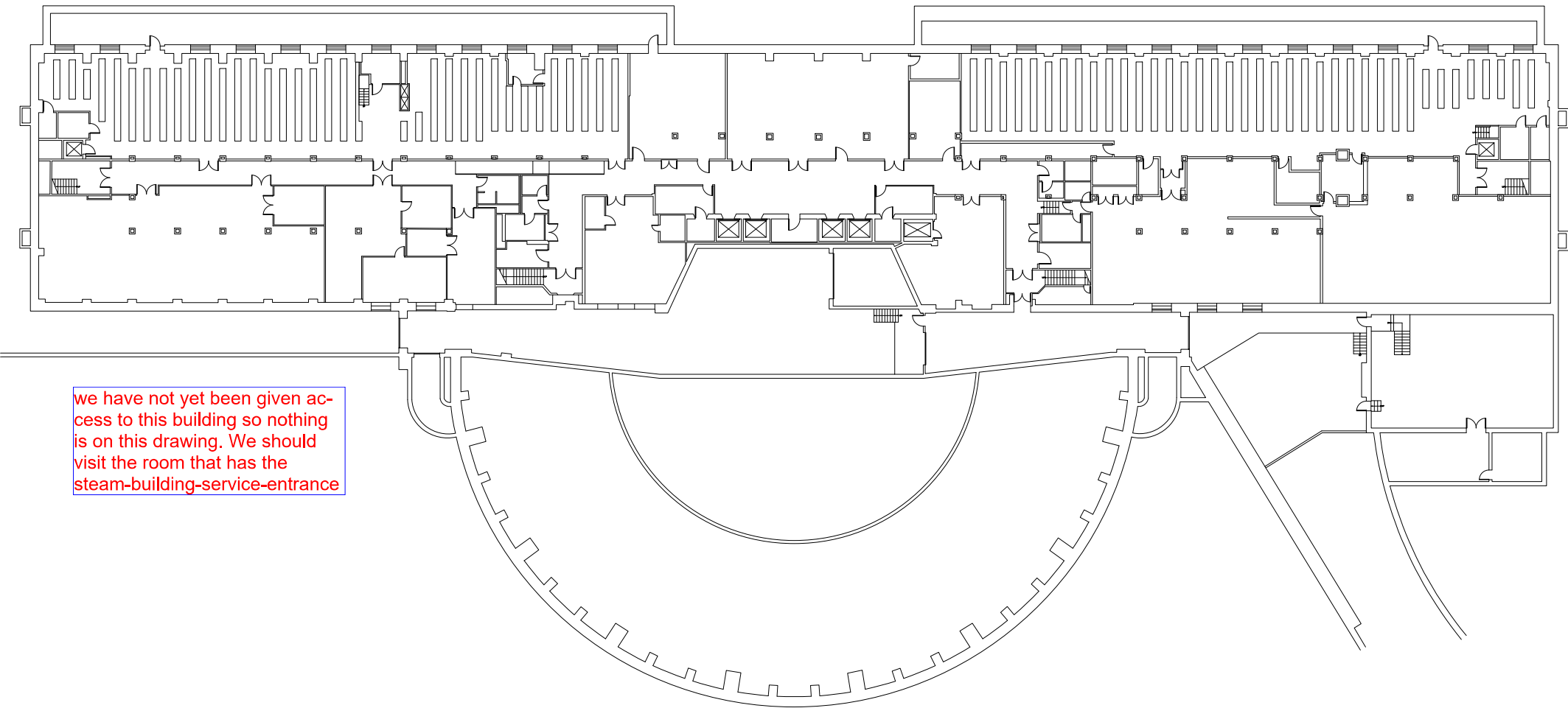
Homogeneous Material Number	Material Type	Material Description	Material Locations	Friable	Sample Numbers	Sample Results	Sample Locations	Asbestos-Containing Material	Approximate Quantity of Asbestos	Condition of Material
18	Thermal Systems Insulation	White 10-inch pipe elbow	Forum Mechanical Room	Yes	HA-18A HA-18B HA-18C	NAD	Forum Mechanical Room	No	N/A	N/A
19	Thermal Systems Insulation	White 10-inch pipe wrap	Forum Mechanical Room	Yes	HA-19A HA-19B HA-19C	NAD	Forum Mechanical Room	No	N/A	N/A

Notes:

NAD = No Asbestos Detected

N/A = Not Applicable

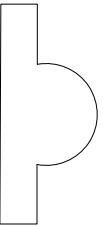
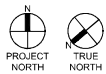
According to EPA, asbestos-containing material (ACM) is defined as any material containing greater than 1% asbestos using laboratory analysis or, by NESHAP, contains less than 10% asbestos is considered positive, unless re-analyzed by PLM point count.



we have not yet been given access to this building so nothing is on this drawing. We should visit the room that has the steam-building-service-entrance

1
M-6
BASEMENT MECHANICAL PLAN
Scale: 1/16" = 1'-0"

MECHANICAL PLAN NOTES
1.
2.
3.



2
M-6
KEY PLAN
Scale: N.T.S

VERIFY SCALE

BAR IS ONE (1) INCH LONG ON ORIGINAL DRAWING:

0 1

IF BAR IS NOT ONE (1) INCH LONG, ADJUST SCALE ACCORDINGLY.

CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS. VARIANCE FROM CONTRACT DOCUMENTS NOT PERMITTED WITHOUT PROFESSIONAL & BUREAU OF CONSTRUCTION APPROVAL.

PROGRAMMING/SCHEMATIC SUBMISSION 01/17/2023		
RECORD REVISIONS		
SIGNATURE	DATE	SIGNATURE DATE
GREENMAN-PEDERSEN, INC 52 GLENMAURA NATIONAL BOULEVARD SCRANTON, PENNSYLVANIA 18505		
COMMONWEALTH OF PENNSYLVANIA DEPARTMENT OF GENERAL SERVICES HARRISBURG, PENNSYLVANIA		
D.G.S. PROJECT No. C-0948-0098 PHASE 1		
AUTOMATION SYSTEM UPGRADE – CAPITOL COMPLEX DEPARTMENT OF GENERAL SERVICES HARRISBURG, DAUPHIN COUNTY, PA		
FORUM BUILDING MECHANICAL PLAN		
DRAWN BY M. SKORANSKI	DATE 01/17/23	DRAWING No. M-6
CHECKED BY M. RADZICKI	SCALE AS NOTED	

APPENDIX C

Photo Logs

APPENDIX C – PHOTO LOG (ACM)



Photograph #1

Positive ACM detection on Grey 12-inch pipe elbow (HA-3)
(Department of Health and Welfare Mechanical Room).



Photograph #2

Positive ACM on Grey 16-inch pipe joint (HA-4)
(Department of Health and Welfare Mechanical Room).

APPENDIX C – PHOTO LOG (LEAD PAINT)



Photograph #3

LCP on red pipe (right) and green cinder block wall (left, orange circle) in North building utility tunnel.

APPENDIX D

Asbestos Laboratory Report and Chain-of-Custody



Environmental Hazards Services, L.L.C.

7469 Whitepine Rd

Richmond, VA 23237

Telephone: 800.347.4010

Asbestos Bulk Analysis Report

Report Number: 23-06-03961

Client: Rhea Engineers & Consultants Inc
333 Rouser Road
Suite 301
Coraopolis, PA 15108

Received Date: 06/26/2023
Analyzed Date: 07/01/2023, 07/02/2023
Reported Date: 07/03/2023

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd Street; Harrisburg, PA 17120

Client Number:
202172

Fax Number:

Laboratory Results

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-001	HA-1A		Yellow/Off-White Fibrous; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-002	HA-1B		Yellow/Off-White Fibrous; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-003	HA-1C		Yellow/Off-White Fibrous; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-004	HA-2A		Off-White Fibrous; Homogeneous	NAD	1% Cellulose 97% Fibrous Glass 2% Non-Fibrous
23-06-03961-005	HA-2B		Off-White Fibrous; Homogeneous	NAD	1% Cellulose 97% Fibrous Glass 2% Non-Fibrous

Rev 1.0 (Revised On: 07/03/2023): Amended client sample #s to read 12ABC, 13ABC.

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-006	HA-2C		Off-White Fibrous; Homogeneous	NAD	2% Cellulose 95% Fibrous Glass 3% Non-Fibrous
23-06-03961-007	HA-3A		Pale Beige-Gray Brittle to Coarse Powder; Homogeneous	4% Chrysotile	3% Cellulose 45% Fibrous Glass 48% Non-Fibrous
Total Asbestos:				4%	
23-06-03961-008	HA-3B			Did Not Analyze (Positive Stop)	
23-06-03961-009	HA-3C			Did Not Analyze (Positive Stop)	
23-06-03961-010	HA-4A		Yellow/White Fibrous; Inhomogeneous	4% Chrysotile	1% Cellulose 90% Fibrous Glass 5% Non-Fibrous
Total Asbestos:				4%	
Chrysotile present in white fibrous mudded TSI-type material.					
23-06-03961-011	HA-4B			Did Not Analyze (Positive Stop)	
23-06-03961-012	HA-4C			Did Not Analyze (Positive Stop)	
23-06-03961-013	HA-5A		Pale Gray/Pale Yellow Fibrous; Inhomogeneous	NAD	3% Cellulose 65% Fibrous Glass 32% Non-Fibrous

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-014	HA-5B		Pale Gray/Off-White Fibrous; Inhomogeneous	NAD	35% Cellulose 35% Fibrous Glass 30% Non-Fibrous
23-06-03961-015	HA-5C		Yellow/Gray/White Fibrous; Inhomogeneous	NAD	3% Cellulose 90% Fibrous Glass 7% Non-Fibrous
23-06-03961-016	HA-6A		White Fibrous; Homogeneous	NAD	98% Fibrous Glass 2% Non-Fibrous
23-06-03961-017	HA-6B		White Fibrous; Homogeneous	NAD	98% Fibrous Glass 2% Non-Fibrous
23-06-03961-018	HA-6C		Yellow Fibrous; Homogeneous	NAD	97% Fibrous Glass 3% Non-Fibrous
23-06-03961-019	HA-7A		Yellow/Off-White Fibrous; Silver Metallic; Inhomogeneous	NAD	4% Cellulose 90% Fibrous Glass 6% Non-Fibrous
23-06-03961-020	HA-7B		Yellow Fibrous; Homogeneous	NAD	97% Fibrous Glass 3% Non-Fibrous
23-06-03961-021	HA-7C		Yellow/Off-White Fibrous; Inhomogeneous	NAD	3% Cellulose 93% Fibrous Glass 4% Non-Fibrous

Rev 1.0 (Revised On: 07/03/2023): Amended client sample #s to read 12ABC, 13ABC.

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-022	HA-8A		White Fibrous; Homogeneous	NAD	98% Fibrous Glass 2% Non-Fibrous
23-06-03961-023	HA-8B		White Fibrous; Homogeneous	NAD	98% Fibrous Glass 2% Non-Fibrous
23-06-03961-024	HA-8C		White Fibrous; Homogeneous	NAD	1% Cellulose 97% Fibrous Glass 2% Non-Fibrous
23-06-03961-025	HA-9A		Yellow/White Fibrous; Silver Metallic; Inhomogeneous	NAD	4% Cellulose 90% Fibrous Glass 6% Non-Fibrous
23-06-03961-026	HA-9B		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 94% Fibrous Glass 5% Non-Fibrous
23-06-03961-027	HA-9C		Yellow Fibrous; Homogeneous	NAD	2% Cellulose 93% Fibrous Glass 5% Non-Fibrous
23-06-03961-028	HA-10A		Brown Fibrous; Homogeneous	NAD	2% Cellulose 92% Fibrous Glass 6% Non-Fibrous

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-029	HA-10B		Brown Fibrous; Homogeneous	NAD	2% Cellulose 92% Fibrous Glass 6% Non-Fibrous
23-06-03961-030	HA-10C		Brown/Beige/White Fibrous; White Pliable; Silver Metallic; Inhomogeneous	NAD	7% Cellulose 85% Fibrous Glass 8% Non-Fibrous
23-06-03961-031	HA-11A		Yellow/Off-White Fibrous; White Pliable to Brittle; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	5% Cellulose 90% Fibrous Glass 5% Non-Fibrous
23-06-03961-032	HA-11B		Yellow/Off-White Fibrous; White Pliable to Brittle; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	5% Cellulose 90% Fibrous Glass 5% Non-Fibrous
23-06-03961-033	HA-11C		Yellow/Off-White Fibrous; White Pliable to Brittle; Amber Adhesive; Silver Metallic; Inhomogeneous	NAD	7% Cellulose 85% Fibrous Glass 8% Non-Fibrous
23-06-03961-034	HA-12A		Yellow/Off-White Fibrous; Yellow Adhesive; Silver Metallic; Inhomogeneous	NAD	5% Cellulose 90% Fibrous Glass 5% Non-Fibrous

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-035	HA-12B		Yellow/Off-White Fibrous; Yellow Adhesive; Silver Metallic; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-036	HA-12C		Yellow/Off-White Fibrous; Yellow Adhesive; Silver Metallic; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-037	HA-13A		Yellow/Tan Fibrous; Inhomogeneous	NAD	3% Cellulose 92% Fibrous Glass 5% Non-Fibrous
23-06-03961-038	HA-13B		Yellow Fibrous; White Pliable; Inhomogeneous	NAD	1% Cellulose 93% Fibrous Glass 6% Non-Fibrous
23-06-03961-039	HA-13C		Yellow/Tan/White Fibrous; White Pliable; Inhomogeneous	NAD	5% Cellulose 90% Fibrous Glass 5% Non-Fibrous
23-06-03961-040	HA-14A		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous
23-06-03961-041	HA-14B		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous

Rev 1.0 (Revised On: 07/03/2023): Amended client sample #s to read 12ABC, 13ABC.

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-042	HA-14C		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 94% Fibrous Glass 5% Non-Fibrous
23-06-03961-043	HA-15A		Off-White/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-044	HA-15B		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous
23-06-03961-045	HA-15C		Yellow Fibrous; Homogeneous	NAD	2% Cellulose 92% Fibrous Glass 6% Non-Fibrous
23-06-03961-046	HA-16A		Off-White/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	8% Cellulose 84% Fibrous Glass 8% Non-Fibrous
23-06-03961-047	HA-16B		Off-White/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	8% Cellulose 84% Fibrous Glass 8% Non-Fibrous
23-06-03961-048	HA-16C		Yellow Fibrous; Homogeneous	NAD	2% Cellulose 94% Fibrous Glass 4% Non-Fibrous

Environmental Hazards Services, L.L.C

Client Number: 202172

Report Number: 23-06-03961

Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-049	HA-17A		Off-White/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	7% Cellulose 85% Fibrous Glass 8% Non-Fibrous
23-06-03961-050	HA-17B		Off-White/Brown/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	11% Cellulose 80% Fibrous Glass 9% Non-Fibrous
23-06-03961-051	HA-17C		Off-White/Yellow Fibrous; Silver Foil; Inhomogeneous	NAD	8% Cellulose 85% Fibrous Glass 7% Non-Fibrous
23-06-03961-052	HA-18A		White Fibrous; Homogeneous	NAD	1% Cellulose 94% Fibrous Glass 5% Non-Fibrous
23-06-03961-053	HA-18B		White Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous
23-06-03961-054	HA-18C		White Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous
23-06-03961-055	HA-19A		Yellow Fibrous; Homogeneous	NAD	95% Fibrous Glass 5% Non-Fibrous

Environmental Hazards Services, L.L.C

Client Number: 202172
Project/Test Address: Harrisburg Capitol Complex; 501 N 3rd
Street; Harrisburg, PA 17120

Report Number: 23-06-03961

Lab Sample Number	Client Sample Number	Layer Type	Lab Gross Description	Asbestos	Other Materials
23-06-03961-056	HA-19B		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 95% Fibrous Glass 4% Non-Fibrous
23-06-03961-057	HA-19C		Yellow Fibrous; Homogeneous	NAD	1% Cellulose 94% Fibrous Glass 5% Non-Fibrous

QC Sample: 56-M12012-2, 57-M22009-1

QC Blank: SRM 1866 Fiberglass

Reporting Limit: 1% Asbestos

Method: EPA Method 600/R-93/116, EPA Method 600/M4-82-020

Analyst: Mark Case, Vickie Holmes

Reviewed By Authorized Signatory:



Tasha Eaddy
QA/QC Clerk

These results are based on a comparative visual estimate. The condition of the samples analyzed was acceptable upon receipt per laboratory protocol unless otherwise noted on this report. Each distinct component in an inhomogeneous sample was analyzed separately and reported as a composite. Results represent the analysis of samples submitted by the client. Sample location, description, area, volume, etc., was provided by the client. This report cannot be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government. This report shall not be reproduced except in full, without the written consent of the Environmental Hazards Service, L.L.C. California Certification #2319 NY ELAP #11714 NVLAP #101882-0 VELAP 460172. All information concerning sampling location, date, and time can be found on Chain-of-Custody. Environmental Hazards Services, L.L.C. does not perform any sample collection.

Environmental Hazards Services, L.L.C. recommends reanalysis by point count (for more accurate quantification) or Transmission Electron Microscopy (TEM), (for enhanced detection capabilities) for materials regulated by EPA NESHAP (National Emission Standards for Hazardous Air Pollutants) and found to contain less than ten percent (<10%) asbestos by polarized light microscopy (PLM). Both services are available for an additional fee.

400 Point Count Analysis, where noted, performed per EPA Method 600/R-93/116 with a Reporting Limit of 0.25%.

* All California samples analyzed by Polarized Light Microscopy, EPA Method 600/M4-82-020, Dec. 1982.

LEGEND: NAD = no asbestos detected

ENVIRONMENTAL HAZARDS SERVICES, LLC

Asbestos Chain of Custody Form

Page 1 of 3

Company Name	Rhea Engineers & Consultants, Inc		Account #	202172
Company Address	333 Rouser Road, Suite 301		City/State/Zip	Moon Twp., PA 15108
Phone	724-443-4111		Email	zach.wicks@rhea.us
Project Name/Test Address	Harrisburg Capitol Complex / 501 N 3rd Street, Harrisburg, PA 17120			
PO Number		Collected By	Mike Stoehr/Erik Hartle	
Turn-Around Time	☒ 5 Day ☐ 3 Day ☐ 2 Day ☐ 1 Day ☐ Same Day / Weekend - Must Call Ahead			

☐ PLM New York Protocol

☐ PLM New Jersey Protocol

☐ PLM South Carolina Protocol

LAB NUMBER	Client Sample ID	Homogeneous Area	Positive Stop	Collection Date & Time	BULK				AIR					COMMENTS	
					PLM	Point Count 400	Point Count 1000	TEM Bulk	PCM	TEM AHERA	NIOSH 7402	Time In Total Minutes	Flow Rate In L/Min		Volume In Total Liters
1	HA-2A	1	X	6/22/23 11:25	X										
2	HA-1B	1		6/22/23 11:25											
3	HA-2C	1		6/22/23 11:25											
4	HA-2A	2		6/22/23 11:30											
5	HA-2B	2		6/22/23 11:30											
6	HA-2C	2		6/22/23 11:30											
7	HA-3A	3		6/23/23 07:50											
8	HA-3B	3		6/23/23 07:50											
9	HA-3C	3		6/23/23 07:50											
10	HA-4A	4		6/23/23 07:55											
11	HA-4B	4		6/23/23 07:55											
12	HA-4C	4		6/23/23 07:55											
13	HA-5A	5		6/23/23 08:00											
14	HA-5B	5		6/23/23 08:00											
15	HA-5C	5		6/23/23 08:00											

Released By:	Mike Stoehr	Date:	6/23/23	Time:	17:30
Signature:	<i>[Signature]</i>				

LAB USE ONLY - BELOW THIS LINE

Received By: T Stone
 Signature: *[Signature]*
 Date: 6/26/23 Time: 3:45 ☐ AM ☒ PM

☐ Portal Contact Added

23-06-03961



Due Date:
07/03/2023

(Monday)

AE 57 PLM P

7469 WHITEPINE RD, RICHMOND, VA 23237 (800)-347-4010

RESULTS VIA CLIENT PORTAL AVAILABLE @ www.leadlab.com

ENVIRONMENTAL HAZARDS SERVICES, LLC

Asbestos Chain of Custody Form

Page 2 of 3

LAB NUMBER	Client Sample ID	Homogeneous Area	Positive Stop	Collection Date & Time	BULK				AIR					COMMENTS
					PLM	Point Count 400	Point Count 1000	TEM Bulk	PCM	TEM AHERA	NIOSH 7402	Time In Total Minutes	Flow Rate In L/Min	
16	HA-6A	6	X	6/23/23 08:20	X									
17	HA-6B	6		08:20										
18	HA-6C	6		08:20										
19	HA-7A	7		08:25										
20	HA-7B	7		08:25										
21	HA-7C	7		08:25										
22	HA-8A	8		08:30										
23	HA-8B	8		08:30										
24	HA-8C	8		08:30										
25	HA-9A	9		08:35										
26	HA-9B	9		08:35										
27	HA-9C	9		08:35										
28	HA-10A	10		09:10										
29	HA-10B	10		09:10										
30	HA-10C	10		09:10										
31	HA-11A	11		09:45										
32	HA-11B	11		09:45										
33	HA-11C	11		09:45										
34	HA-12A	12		10:00										
35	HA-12B	12		10:00										
36	HA-12C	12		10:00										
37	HA-13A	13		10:15										
38	HA-13B	13		10:15										
39	HA-13C	13		10:15										
40	HA-14A	14		10:20										
41	HA-14B	14		10:20										
42	HA-14C	14		10:20										
43	HA-15A	15		10:35										
44	HA-15B	15		10:35										
45	HA-15C	15		10:35										

Received By: T Stone

EHS Order #: 3961

Signature: T Stone

Date: 6/26/23 Time: 3:45 AM



ENVIRONMENTAL HAZARDS SERVICES, LLC

Asbestos Chain of Custody Form

Page 3 of 3

Company Name	Rhea Engineers & Consultants, Inc	Account #	202172
Company Address	333 Rouser Road, Suite 301	City/State/Zip	Moon Twp., PA 15108
Phone	724-443-4111	Email	zach.wicks@rhea.us
Project Name/Test Address Harrisburg Capitol Complex / 501 N 3rd Street, Harrisburg, PA 17120			
PO Number		Collected By	Mike Stoehr/Erik Hartle
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☐ PLM New York Protocol

☐ PLM New Jersey Protocol

☐ PLM South Carolina Protocol

LAB NUMBER	Client Sample ID	Homogeneous Area	Positive Stop	Collection Date & Time	BULK				AIR						COMMENTS
					PLM	Point Count 400	Point Count 1000	TEM Bulk	PCM	TEM AHERA	NIOSH 7402	Time In Total Minutes	Flow Rate In L/Min	Volume In Total Liters	
1	HA-16A	16	X	6/23/23 11:00	X										
2	HA-16B	16													
3	HA-16C	16													
4	HA-17A	17													
5	HA-17B	17													
6	HA-17C	17													
7	HA-18A	18													
8	HA-18B	18													
9	HA-18C	18													
10	HA-19A	19													
11	HA-19B	19													
12	HA-19C	19													
13															
14															
15															

Released By:	Mike Stoehr	Date:	6/23/23	Time:	17:30
Signature:	<i>[Signature]</i>				

LAB USE ONLY – BELOW THIS LINE

Received By: T Stone

Signature: *T Stone*

Date: 6.26.23 Time: 3:45 ☐ AM ☒ PM

☐ Portal Contact Added



Attach Laboratory Label Here

7469 WHITEPINE RD, RICHMOND, VA 23237 (800)-347-4010

RESULTS VIA CLIENT PORTAL AVAILABLE @ www.leadlab.com

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The Specifications sections "General Conditions of the Construction Contract", "Special Conditions: and "Division 1 – General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes: Penetration firestopping systems.

1.03 ACTION SUBMITTALS

- A. Product Data: Penetration firestopping systems.
 - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly developed in accordance with current International Firestop Council (IFC) guidelines. Obtain approval of authorities having jurisdiction prior to submittal.

1.04 CLOSEOUT SUBMITTALS

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.05 QUALITY CONTROL

- A. Installer Qualifications: A firm that has been approved by FM Approvals according to FM Approvals 4991, "Approval Standard for Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.07 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
 - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
 - 2. Test in accordance with testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
 - a. Penetration firestop systems installed with products bearing the classification marking of a qualified product certification agency in accordance with listed system designs published by a qualified testing agency.
 - 1) UL in its online directory "Product iQ."
 - 2) Intertek Group in its "Directory of Building Products."
 - 3) FM Approvals in its "Approval Guide."

2.02 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems are to be compatible with one another, with the substrates forming openings, and with penetrating items if any.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. 3M Fire Protection Products.
 - b. Hilti, Inc.
 - c. Specified Technologies, Inc. (STI)
 - d. Or approved equal by the Design Professional.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: Not less than the fire-resistance rating of the wall penetrated.
 - 2. Membrane Penetrations: Install recessed fixtures such that the required fire resistance will not be reduced.

- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined in accordance with ASTM E814 or UL 1479.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of the floor penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of the floor. The following floor penetrations do not require a T-rating:
 - a. Those within the cavity of a wall.
 - b. Floor, tub, or shower drains within a concealed space.
 - c. 4-inch or smaller metal conduit penetrating directly into metal-enclosed electrical switchgear.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined in accordance with UL 1479.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, in accordance with ASTM E84.
 - 1. Sealant shall have a VOC content of 250 g/L or less.
 - 2. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- F. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.
 - 2. Substrate primers.
 - 3. Collars.
 - 4. Steel sleeves.

2.03 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.

- F. Intumescent Wrap Strips: Single-component intumescent elastomeric strips for use around combustible penetrants.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Compressible, removable, and reusable intumescent pillows encased in fire-retardant polyester or glass-fiber cloth. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.
- K. Fire-Rated Cable Sleeve Kits: Complete kits designed for new or existing cable penetrations through walls to accept standard accessories.
- L. Thermal Wrap: Flexible protective wrap tested and listed for up to 2-hour fire ratings in accordance with ASTM E814 or UL 1479 for membrane penetrations or ASTM E1725 or UL 1724 for thermal barrier and circuit integrity protection.
- M. Fire-Rated Cable Pathways: Single or gangable device modules composed of a steel raceway with integral intumescent material and requiring no additional action in the form of plugs, twisting closure, putty, pillows, sealant, or otherwise to achieve fire and air-leakage ratings.
- N. Retrofit Device for Cable Bundles: Factory-made, intumescent, collar-like device for firestopping existing over-filled cable sleeves and capable of being installed around projecting sleeves and cable bundles.
- O. Wall-Opening Protective Materials: Intumescent, non-curing putty pads or self-adhesive inserts for protection of electrical switch and receptacle boxes.
- P. Fire-Rated HVAC Retaining Angles: Steel angle system with integral intumescent firestop gasket for use around rectangular steel HVAC ducts without fire dampers.
- Q. Firestop Plugs: Flexible, re-enterable, intumescent, foam-rubber plug for use in blank round openings and cable sleeves.
- R. Fire-Rated Cable Grommet: Molded two-piece grommet made of plenum-grade polymer and foam inner core for sealing small cable penetrations in gypsum walls up to 1/2 inch in diameter.
- S. Closet Flange Gasket: Molded, single-component, flexible, intumescent gasket for use beneath a water closet (toilet) flange in floor applications.
- T. Endothermic Wrap: Flexible, insulating, fire-resistant, endothermic wrap for protecting membrane penetrations of utility boxes, critical electrical circuits, communications lines, and fuel lines.

2.04 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.

3.03 INSTALLATION OF PENETRATION FIRESTOPPING SYSTEMS

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.05 FIELD QUALITY CONTROL

- A. Owner may engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.06 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The Specifications sections "General Conditions of the Construction Contract", "Special Conditions: and "Division 1 - General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. This Section includes acoustical tiles for ceilings and the following:
 - 1. Acoustical Metal ceiling panels.
 - 2. Exposed suspension systems.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For components with factory-applied color finishes.
- C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
 - 1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
 - 2. Concealed Suspension System Members: 12-inch long Sample of each type.
 - 3. Exposed Moldings and Trim: Set of 12-inch long Samples of each type and color.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical tile ceiling.
- E. Maintenance Data: For finishes to include in maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.
- B. Source Limitations:
 - 1. Acoustical Ceiling Tile: Obtain each type through one source from a single manufacturer.

2. Suspension System: Obtain each type through one source from a single manufacturer.
- C. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system through one source from a single manufacturer.
- D. Fire-Test-Response Characteristics: Provide acoustical tile ceilings that comply with the following requirements:
 1. Fire-Resistance Characteristics: Where indicated, provide acoustical tile ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - b. Identify materials with appropriate markings of applicable testing and inspecting agency.
 2. Surface-Burning Characteristics: Provide acoustical tiles with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
 - a. Smoke-Developed Index: 450 or less.
- E. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
 2. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings--Seismic Zones 0-2."
 3. CISCA's Guidelines for Systems Requiring Seismic Restraint: Comply with CISCA's "Guidelines for Seismic Restraint of Direct-Hung Suspended Ceiling Assemblies--Seismic Zones 3 & 4."
 4. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."
 5. ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.06 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

1.07 COORDINATION

- A. Coordinate layout and installation of acoustical tiles and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.01 ACOUSTICAL TILES, GENERAL

- A. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
- B. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.02 ACOUSTICAL TILES FOR ACOUSTICAL TILE CEILING

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Ceiling tiles shall match the existing building standard.
- C. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Armstrong World Industries, Inc
 - 2. BPB USA;
 - 3. USG Interiors, Inc.

2.03 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- B. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
- C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
 - a. Type: Postinstalled expansion or Postinstalled bonded anchors.
 - b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
 - c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchors.
- D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch diameter wire.
- E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- F. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch thick, galvanized steel sheet complying with ASTM A 653/A 653M, G90coating designation; with bolted connections and 5/16-inch diameter bolts.
- G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.
- H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

2.04 METAL SUSPENSION SYSTEM FOR ACOUSTICAL TILE CEILING

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Armstrong World Industries, Inc
 - 2. BPB USA;

3. USG Interiors, Inc.
- C. Direct-Hung, Double-Web Suspension System: Main and cross runners roll formed from and capped with cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, G30coating designation.
1. Structural Classification: Heavy-duty system.
 2. Access: Upward with initial access openings of size indicated below and located throughout ceiling within each module formed by main and cross runners, with additional access available by progressively removing remaining acoustical tiles.
 - a. Initial Access Opening: In each module, Match Existing.

2.05 METAL EDGE MOLDINGS AND TRIM

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
- B. Products: Subject to compliance with requirements, provide one of the following:
1. USG Interiors, Inc.
 2. Armstrong World Industries, Inc.
 3. BPB USA.
 4. Chicago Metallic Corporation.
- C. Basis-of-Design Product: Subject to compliance with requirements, provide USG Interiors, Inc. or a comparable product by one of the following:
1. Armstrong World Industries, Inc.
 2. BPB USA.
 3. Chicago Metallic Corporation.
- D. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.
1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
 2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- E. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

3. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
4. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):
 - a. Manufacturer's standard factory-applied prime-coat finish ready for field painting.
5. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting, enamel primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.

2.06 ACOUSTICAL SEALANT

- A. Acoustical Sealant: As specified in Division 07 Section 079200 "Joint Sealants."
 1. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical tile ceilings.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL

- A. The ceiling scope is limited to those spaces where acoustical tile/grid suspension type ceilings are required to be removed temporarily to facilitate pipework above the ceilings.
- B. The intent is to remove the ceilings, carefully store the materials and reinstall. However, the removal and reinstallation process is not always possible. As part of the contract the contractor shall return the ceilings to their condition at project commencement (or better) after the ceiling removal and pipe installation by whatever means and methods are required.
- C. Besides the spaces explicitly called out on the drawings requiring ceiling work, the contractor shall expose above ceiling space for the routing of control and electrical conduits between panels, control panels and instrumentation. Ceilings shall be put back in place after the work is

complete.

3.03 PREPARATION

- A. Record original location of all grid before removal so that the ceiling can be seamlessly reset after above ceiling mechanical work is completed.

3.04 INSTALLATION, SUSPENDED ACOUSTICAL TILE CEILINGS

- A. General: Install acoustical tile ceilings to comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
 - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 4. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 6. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both structure to which hangers are attached and type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 - 7. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 8. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 9. Do not attach hangers to steel deck tabs.
 - 10. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 11. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
 - 12. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers,

without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 - 2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 - 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
 - 1. As indicated on reflected ceiling plans.
 - 2. Install tiles with pattern to match existing.
 - 3. Install tiles in a basket-weave pattern.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 - 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches o.c.
 - 3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.05 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:
 - 1. Suspended ceiling system.
 - 2. Hangers, anchors and fasteners.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- C. Tests and Inspections: Testing and inspecting of completed installations of acoustical tile ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.
 - 1. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed.
 - a. Within each test area, testing agency will select 1 of every 10 power-actuated

fasteners and postinstalled anchors used to attach hangers to concrete and will test them for 200 lb of tension; it will also select one of every 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lb of tension.

- b. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.
- D. Remove and replace acoustical tile ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

3.06 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

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SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Sleeves.
 - 4. Escutcheons.
 - 5. Plumbing demolition.
 - 6. Equipment installation requirements common to equipment sections.
 - 7. Painting and finishing.
 - 8. Supports and anchorages.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.04 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
- B. Welding certificates.

1.05 QUALITY CONTROL

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.07 COORDINATION

- A. Cut openings in building structure to allow for plumbing installations. Do not cut structural beams, girders, columns without the analysis and approval of a licensed structural engineer.
- B. Provide required supporting devices and structural augmentations to properly support pipe as needed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent.

2.02 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.04 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
 - c. Watts
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.

- d. Victaulic Co. of America.
- 2. Include one for each sealing element.

PART 3 - EXECUTION

3.01 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Abandon no pipe.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment/Devices/Instruments to Be Removed and Reinstalled/Relocated: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational in accordance with manufacturer's written installation and operations instructions.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings. For meter installation, additional offsets and transitions will be required to meet the manufacturer's installation requirements including the required straight pipe lengths necessary for repeatable, accurate measurements by the installed meters. Such offsets, transitions and installation of additional pipe shall be provided at no increase to the contract sum and the changes shall be shown on shop drawings generated by the plumbing contractor with pipe, meters, valves and support shown along with adjacent structure, partitions and relevant building systems.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal. Gas pipe in the L&I building will be installed above ceiling near the gas service entrance to the building.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation. All domestic water pipe shall be insulated and a vapor barrier shall be effected.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Sleeves are not required for core-drilled holes.
- M. Permanent sleeves are not required for holes formed by removable PE sleeves.
- N. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials. Submit a drawing of the UL listed firestopping system intended to be used and the manufacturer's products named in the firestopping system drawing.
- O. Verify final equipment locations for roughing-in.
- P. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. 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 unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- 3.04 PIPING CONNECTIONS
- A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.
- 3.05 EQUIPMENT/INSTRUMENT INSTALLATION - COMMON REQUIREMENTS
- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- 3.06 PAINTING
- A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- 3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES
- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

END OF SECTION

SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Meters
 - 2. Flow straighteners/conditioners.
- B. Report:
 - 1. Field Calibration activities and results.
 - 2. Startup calibration documentation for review/record.

1.03 SUMMARY

- A. Section Includes:
 - 1. Differential Pressure Meters for Natural Gas.
 - 2. Electromagnetic Meters for Domestic Water.
 - 3. Accessories and Installation.

1.04 WARRANTY

- A. For all metering devices, the greater of:
 - 1. One year or,
 - 2. Manufacturer's standard warranty.

PART 2 - PRODUCTS

2.01 THERMAL MASS FLOW METERS FOR NATURAL GAS

- A. **Basis of Design product for natural gas: Onicon F-5500 Inline Thermal Mass Flow Meter.**
- B. Subject to compliance with specified requirements, manufacturer's products that may be incorporated into the Work include, the following or Government approved equivalents.
 - 1. Sage Paramount (400 Series) Industrial Thermal Mass Flow Meter

2. Endress+Hauser Proline t-mass I 300 Thermal mass flowmeter.
- C. Inline model: Flow Element is In-Line style consisting of 316 Stainless Steel Schedule 40 Flow Bodies.
 - D. Sensing Method: Thermal mass flow utilizing direct digital control sensing circuitry.
 - E. The flow meter shall provide SFPM or SCFM flow readings from a pair of encapsulated platinum sensors and shall not require additional temperature or pressure compensation.
 - F. NEMA 4X Weathertight aluminum enclosure.
 - G. Easy-to-read user interface/display that provides rate and total data.
 - H. Standard accuracy is +/- 1% of Full Scale +/- 2% of reading with a turndown of 100 to 1 and resolution as much as 1000 to 1.
 - I. Pressure Drop: less than ½ inch water column.
 - J. Provide a flow conditioner as required to meet the manufacturer's combined minimum upstream and downstream straight pipe run requirement. With some inline models a flow conditioner is integral to the meter.
 1. The basis of design product requires a downstream straight pipe length of 5 pipe diameters. The upstream straight pipe length is required to be 15 pipe diameters without a flow conditioner but 3 pipe diameters with a flow conditioner.
 2. For pipe arrangements where the upstream pipe contains multiple bends, pipe size expansion, tees, or a modulating valve, the straight pipe length required upstream of the basis of design meter is required to measure 10 pipe diameters when a flow conditioner is used.
 3. Consult the actual selected/submitted meter manufacturer's installation literature and comply with the requirements for straight pipe length and flow conditioner position. Additional pipe may need to be added to the piping configuration based on the meter selected as part of the contract sum.
 - K. Repeatability: 0.2%.
 - L. Input Power: 24VDC nominal. A DC range from 12 to 28 VDC shall be acceptable.
 - M. Electronics:
 1. Isolated 4 to 20 mA output proportional to Mass Flow Rate.
 2. Programmable pulsed output of flow and totalized Flow
 3. The meter shall be equipped with an integrally mounted display with a user interface that allows for field programming of the meter.
 4. BACnet or Ethernet/IP shall be acceptable as compatible with the subject building's control system. BACnet is preferred.
 5. Internal diagnostics functions shall be part of the standard utility software provided with the meter including a zero flow calibration check.

2.02 ELECTROMAGNETIC METERS FOR DOMESTIC WATER

A. Basis of Design Product: Ultra Mag by McCrometer

- B. Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include the following or Government approved equivalent:
 - 1. Onicon Inc F3200 Inline
 - 2. Rosemount 8700 Series Inline
- C. Measurement System: The entire Measurement System shall be built and calibrated by the same manufacturer shall include all required mechanical installation hardware.
- D. Flow Meter: Refer to meter schedule on drawings. The flow meter shall be installed in the domestic water supply pipe of the system to be measured following the manufacturer's instructions with particular attention to upstream and downstream straight pipe runs.
- E. Inline (full bore) Electromagnetic Type:
 - 1. Electromagnetic Flow Meter complete with integral or remote electronics module.
 - a. The electronics module shall include a backlit graphic display and keypad.
 - b. Connections to the piping shall be ANSI class 150 flanges.
 - c. Provide suitable mating flanges.
 - d. The flow tube and the sensing electrodes shall be 316SS or the manufacturer's standard material.
 - e. The liner shall be polypropylene or ebonite for low temperature service.
 - f. Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 3 to 33 feet per second velocity.
 - 1) A certificate of calibration shall be provided with each flow meter.
 - 2) Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow.
 - g. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install meters in accessible locations to allow for meter removal and ease of reading/programming the transmitter/converter. Where meters are located above hard ceilings or inaccessible locations install access panels to allow access to meters. Minimum access panel size shall be 24" x 24". Where meters are above suspended grid ceilings provide preprinted labels affixed to grid to identify the location where the meters are located. Above ceiling meters shall be equipped with sufficient cabling to mount the meter below the ceiling at eye level.
- B. To avoid start up delays due to fouling of devices with loosened slag/debris from disturbed existing pipe, after cutting away the pipe where the meter and new pipe will be installed, and before installation, thoroughly clean the inside of the pipe on both the upstream and downstream sides of the meter and/or new pipe location(s).
- C. Install meters according to manufacturer's instructions.

- D. In horizontal pipe runs, install meters so that the junction box is vertical insuring the electrodes are positioned to prevent coating by sediments or loss of electrode contact due to air bubbles.
- E. The flow meter location shall meet the manufacturer's minimum upstream and downstream straight pipe run requirement. Install flowmeters with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
 - 1. Where required and approved by the meter manufacturer, a flow straightener / flow conditioner shall be provided.
 - 2. The basis of design meter provides the least required upstream and downstream pipe lengths. Use of the alternate named manufacturers' products may result in additional straight pipe lengths and pipe modifications along with support appurtenances, insulation and all other hardware required to meet the performance requirements of the project. Such additional pipe and complementary materials shall be provided at no additional contract cost.
- F. Assemble and install cables, connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- G. Install permanent indicators on walls or brackets in accessible and readable positions.
 - 1. Personnel shall not be required to use a ladder to read or program meters.
- H. Install connection fittings in accessible locations for attachment to portable indicators.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment. Sensing lines shall be configured to be opened, inspected, and cleaned or rodded.
- B. The MC will provide wiring between the meter transmitters and the building automation system.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
 - 1. Field Calibration by a factory authorized representative shall be performed regardless of factory calibration and documentation.
 - 2. Run internal a zero flow calibration check diagnostic function for field validation of the factory zero flow calibration. Print a certificate validating the test results.
- B. Adjust faces of meters' displays and gages to proper angle for best visibility.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Iron gate valves.
- B. Related Sections:
 - 1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
 - 2. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.

1.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.05 QUALITY CONTROL

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set gate valves closed to prevent rattling.
 - 4. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Isolation: All valves shall be designed for positive stop of the fluids in the piping system in which they are installed.
- C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- D. Valve Sizes: Same as upstream piping unless otherwise indicated.
- E. Domestic Water Valves shall be designed for use in potable water applications and shall meet the EPA's Safe Drinking Water Act Section 1417 low lead requirements.
- F. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Hand lever: For quarter-turn valves NPS 6 and smaller.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- G. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

H. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.03 CAST IRON WAFER BUTTERFLY VALVE

A. Description

1. Wafer Connection
 - a. Compatible with Pipe Flange Classes: Class 125, Class 150
2. Cast Iron Body.
3. Disc: Ductile Iron or Aluminum Bronze.
4. Operation:

- a. Lever Handle
- b. Gear Drive with wheel and indicator.

5. Minimum Working Pressure: 200 Psi

2.04 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Flo Fab Inc.
- e. Hammond Valve.
- f. Kitz Corporation.
- g. Legend Valve.
- h. Milwaukee Valve Company.
- i. NIBCO INC.
- j. Powell Valves.
- k. Red-White Valve Corporation.
- l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- m. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-70, Type I.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM A 126, gray iron with bolted bonnet.
- d. Ends: Flanged.
- e. Trim: Bronze.
- f. Disc: Resilient wedge.
- g. Packing and Gasket: Asbestos free.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is

suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION

- A. Clean the pipe before and after the new valve thoroughly.
- B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- C. Locate valves for easy access and provide separate support where necessary.
- D. Install valves in horizontal piping with stem at or above center of pipe.
- E. Install valves in position to allow full stem movement.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Bronze Ball or Iron Gate valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

3.05 DOMESTIC WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Ball Valves.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Gate Valves.

END OF SECTION

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SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Pipe stands.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
 - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.05 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.

- C. Welding certificates.

1.06 QUALITY CONTROL

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Copper-Plated Steel Swivel Loop Hangers for copper tubing.
 - 5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 6. Clevis Hangers for Insulated Piping
 - a. Designed to fit the OD (Outside Diameter) of the pipe insulation.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- D. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install lateral bracing with pipe hangers and supports to prevent swaying.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- H. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - b. Use clevis saddle pipe hangers in conjunction with a Pipe Shield and pipe supports to prevent damage to the pipe insulation.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

3.02 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers .
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.03 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.04 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.05 HANGER AND SUPPORT

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use copper plated hangers or apply nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers and attachments for general service applications.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 4. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 - 5. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 - 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - 6. C-Clamps (MSS Type 23): For structural shapes.
 - 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of greater length recommended in writing by manufacturer or as above in this specification section to prevent crushing insulation.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 2. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme formulated in coordination with the facilities' management.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION

- 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.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances 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. Fasteners: Stainless-steel rivets.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's unique equipment number as designated by the facilities' management.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, 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 using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.03 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material:
 - a. Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - b. Aluminum
 - c. Plastic
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
 3. Size: Credit Card Size (3.375 inches wide by 2.125 inches high) or larger.
- B. Engraved Valve Tags, Custom Stamped Plumbing Labels, Laser Engraved Plastic, Aluminum or Brass Tags, Water and Gas Shut off Tags.

- C. Data:
 - 1. Valve Service
 - 2. Valve Size
- D. 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. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.
- B. Set meeting and consult with the government's facilities management team to determine content on equipment and valve labels.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of equipment.
- B. Locate equipment labels where accessible and visible.
- C. Labels for meters shall match tags on the drawings and names in schedules on drawings. Where more than one meter shares a name add '#of#' as appropriate.

3.03 PIPE LABEL INSTALLATION

- A. 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. Near each valve and control device.
 - 2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 3. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 4. On both sides of new meters installed in piping systems
- B. Pipe Label Color Schedule:
 - 1. Domestic Cold Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.

2. Natural Gas Piping:
 - a. Background Color: Yellow
 - b. Letter Color: Black.

3.04 VALVE-TAG INSTALLATION

- A. Install tags on valves, flow meters in piping systems, and control devices in piping systems; and shutoff valves. List tagged valves in a valve schedule. The tags shall be installed on the new or existing valve that is first encountered upstream of the new meter and, if applicable, that valve or valves first encountered downstream of the new meter.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape:
 - a. Domestic Cold Water: 1-1/2 inches round.
 - b. Natural Gas: 1-1/2 inches round.
 2. Valve-Tag Color:
 - a. Domestic Cold Water: Natural.
 - b. Natural Gas: Natural.
 3. Letter Color:
 - a. Domestic Cold Water: Black
 - b. Natural Gas: Black.

END OF SECTION

SECTION 220700 PLUMBING INSULATION

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Mineral fiber.
 - 2. Insulating cements.
 - 3. Adhesives.
 - 4. Mastics.
 - 5. Sealants.
 - 6. Factory-applied jackets.
 - 7. Tapes.
 - 8. Securements.
- B. Related Sections include the following:
 - 1. Division 23 Section "HVAC Insulation."

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.04 QUALITY CONTROL

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation).

- d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.02 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Johns Manville
 - b. Oatey
 - c. Brock White
 - d. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.04 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 2. The All Service Jacket shall effect a vapor barrier.

2.05 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.06 SECUREMENTS

- A. Bands:

1. Products: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
 3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- C. Wire: 0.080-inch nickel-copper alloy.
1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.07 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation 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.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a

corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. 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.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. 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.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with 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 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. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 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. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. 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.
- P. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.

3.05 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more

specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions on Domestic Water Pipe:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, 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.

C. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of

- mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Minimum thickness of elastomeric insulation shall be 1 inch for all applications.

3.07 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.08 FINISHES

- A. Color: White. Vary first and second coats to allow visual inspection of the completed Work.

3.09 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Gas Pipe

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 1. NPS 2 and Smaller: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick with vapor barrier.
 2. NPS 2 1/2 and Larger: Insulation shall be one of the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick with vapor barrier.

END OF SECTION

SECTION 220800 - PLUMBING SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Section 019100 - Commissioning Requirements.
- C. All Division 22 Specification Sections apply to this Section.

1.03 SYSTEMS TO BE COMMISSIONED

- A. The Plumbing Systems that shall be commissioned in this project include the following:
 - 1. Utility Metering Systems including Domestic Water & Natural Gas.

1.04 SCHEDULING

- A. The CxA will provide the initial schedule of primary commissioning events using the information gathered from the commissioning scoping meeting. The Commissioning Plan provides a format for this schedule. The timeline is fine-tuned as construction progresses. In particular, 30 days prior to startup of the primary HVAC equipment, the CxA meets with the DGS, the CA and Contractors and develops a detailed commissioning schedule. The CxA will approve the commissioning schedule.
 - 1. Lead Contractor shall coordinate requirements of Construction Scheduling with this work.

PART 2 – PRODUCTS

2.01 TEST EQUIPMENT

- A. The Plumbing Contractor (0.3 Contractor) shall provide all equipment necessary to fulfill the testing requirements of Division 22.

PART 3 – EXECUTION

3.01 RESPONSIBILITIES

- A. Commissioning of a system or systems specified in this Division is part of the construction process. Documentation and testing of these systems, as well as training of DGS or the Client

Agency's operation and maintenance personnel, is required in cooperation with DGS or the Client Agency's Representative and the CxA. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 01 Sections on Project Closeout and General Commissioning and Section 019100 for substantial completion details and detailed commissioning requirements.

- B. Plumbing Contractor (0.3 Contractor). The commissioning responsibilities applicable to Division 22 for the Plumbing Contractor are as follows:

Construction and Acceptance Phase

1. Attend the initial commissioning meeting conducted at the start of construction, the commissioning meeting held 30 days prior to startup of the primary equipment, and all commissioning team meetings.
2. Copies of approved shop drawings and startup reports for all commissioned equipment shall be submitted to the CxA through E-Builder. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.
3. The Operation and Maintenance Manuals shall be submitted to the CxA, through E-Builder prior to the start of training (3 weeks before start-up and training and at least 60 days before substantial completion). Manuals shall include recommended operating procedures.
4. Perform and clearly document all completed startup and system operational checkout procedures and prefunctional checklist providing copies to the CxA. Refer to Section 01900.
5. During the startup and initial checkout process, execute all portions of the manufacturer's start-up checklists and prefunctional checklists for all commissioned Plumbing equipment. Refer to Section 01900.
6. Submit completed installation and readiness checklists, startup reports, and Manufacturer / Contractor testing results including acceptance testing to E-Builder for all commissioned equipment.
7. Submit Operation and Maintenance Manuals to E-Builder a minimum of three (3) weeks prior to the start of training. Manuals shall include recommended operating procedures.
8. Address current Professional punch list items and Commissioning corrective action items before functional and/or acceptance testing.
9. Provide skilled technicians to execute starting of equipment and to execute functional tests in accordance with all Division 22 sections. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
10. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and Professional and retest the equipment.
11. Provide training of the Client Agency's operation and maintenance personnel using expert qualified training personnel, as specified.
12. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

Warranty Period

13. Correct deficiencies and make necessary adjustments to O&M manuals for applicable issues identified in any seasonal testing.

3.02 SUBMITTALS

- A. The CxA shall access the Contractor's submittals through e-Builder. The CA will review the submittals for commissioning related requirements and provide any comments to the Professional for inclusion in their comments.

3.03 STARTUP

- A. The Plumbing Contractor (0.3 Contractor) shall follow the equipment manufacturer's start-up and initial checkout procedures. Equipment start-up is required to complete systems and sub-systems so they are fully functional, in compliance with the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Agent, DGS or Client Agency.
- B. Testing is intended to begin upon completion of a system. Refer to Section 019100 for additional information related to scheduling.

3.04 TESTS

- A. Refer to applicable Division 22 sections for a description of the process, specific details, and/or standards referenced for acceptance testing.
- B. The Plumbing Contractor (0.3 Contractor) shall complete and document all startup and acceptance testing in accordance with all Division 22 sections. In addition, provide the necessary support to execute functional testing, as directed by the CxA.
- C. At the CxA's discretion, if large numbers or repeated deficiencies are encountered, the CxA shall suspend functional testing until the Contractor corrects the deficiencies and troubleshoots all remaining systems at issue on their own. The Contractor shall be responsible for any resulting schedule delays that increase the overall time period to complete functional testing.

3.05 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the filled-out start-up, initial checkout, and test documentation in accordance with all Division 22 sections.

END OF SECTION

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SECTION 221116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Water meters.
- B. Related Section:
 - 1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.03 SUBMITTALS

- A. Product Data: For the following products:
 - 1. Domestic Water Piping
 - 2. Dielectric fittings.
 - 3. Flexible connectors.
 - 4. Water meters.

1.04 QUALITY CONTROL

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.05 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Construction Manager and/or Government no fewer than five days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without Construction Manager's and Government's written permission. Interruption of water service may only be during normal building unoccupied hours.

1.06 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
 - 1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.03 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
 - 2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Plain-End, Ductile-Iron Pipe: AWWA C151.
 - 1. Grooved-Joint, Ductile-Iron-Pipe Appurtenances:
 - a. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - 1) Anvil International.
 - 2) Shurjoint Piping Products.
 - 3) Star Pipe Products.
 - 4) Victaulic Company.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.

- c. Grooved-End, Ductile-Iron-Pipe Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.04 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.05 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - d. Wilkins; a Zurn company.
 - 2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 150 psig minimum at 180 deg F.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
 - 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - d. Wilkins; a Zurn company.
 - 2. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 150 psig.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

- 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Central Plastics Company.
 - d. Pipeline Seal and Insulator, Inc.
- 2. Description:
 - a. Nonconducting materials for field assembly of companion flanges.
 - b. Pressure Rating: 150 psig.
 - c. Gasket: Neoprene or phenolic.
 - d. Bolt Sleeves: Phenolic or polyethylene.
 - e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

- 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Elster Perfection.
 - b. Grinnell Mechanical Products.
 - c. Matco-Norca, Inc.
 - d. Precision Plumbing Products, Inc.
 - e. Victaulic Company.
- 2. Description:
 - a. Standard: IAPMO PS 66
 - b. Electroplated steel nipple. complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.06 WATER METERS

A. Building Systems Monitoring Water Meters:

- 1. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig minimum working pressure.
 - c. See 220519 – “METERS AND GAGES FOR PLUMBING PIPING.”

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination/Shop Drawings.
- B. Install shutoff valve immediately upstream of each dielectric fitting.
- C. Install domestic water piping level without pitch and plumb.
- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas. All work shall be in "back of house" utility spaces.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install sleeves for piping penetrations of walls, ceilings, and floors.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs.
- O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.02 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

- D. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- E. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.03 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valves outside the required straight pipe lengths before and after meters.
 - 1. Use ball or gate valves for piping NPS 2 and smaller.
 - 2. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
- C. Where a valve is already in place within view of the new meter (and is verified to hold, positively stop the subject fluid) and additional valve shall not be required.

3.04 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.05 WATER METER INSTALLATION

- A. Rough-in domestic water piping, and install water meters according to manufacturer's requirements.
- B. Water meters will be furnished and installed by Contractor.
- C. Install water meters according to AWWA M6, Manufacturer's requirements, and the following:
- D. Install remote registration system according to standards of Manufacturer and the Building Management System.

3.06 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 FeetIf Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.

- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 - 6. NPS 6: 10 feet with 5/8-inch rod.
 - 7. NPS 8: 10 feet with 3/4-inch rod.
- E. Install supports for vertical copper tubing every 10 feet.
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 - 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 - 3. NPS 2: 10 feet with 3/8-inch rod.
 - 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 - 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 - 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 - 7. NPS 6: 12 feet with 3/4-inch rod.
 - 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- G. Install supports for vertical steel piping every 15 feet.
- H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Make adjustments based on actual field conditions encountered. Show on shop drawings.

3.08 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.
- C. Identify pipe service, flow direction and pipe size.

3.09 FIELD QUALITY CONTROL

A. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

C. Domestic water piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

B. Plastic pipe shall not be permitted for any services.

C. Domestic Cold water piping shall generally be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints.

3.11 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Shutoff Duty:
 - a. Use ball or gate valves for piping NPS 2 and smaller.
 - b. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
 - 2. Drain Duty: Hose-end drain valves.

END OF SECTION

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SECTION 221123 - FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping and tubing joining materials.
 - 3. Valves.
- B. Installation is limited to miscellaneous pipe work in connection with new meter installation.

1.03 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Dielectric fittings.

1.05 QUALITY CONTROL

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

- 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.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.07 PROJECT CONDITIONS

- A. The gas pressure in the subject buildings is set to 7 inches water column with a pressure relief that will release at 14 inches water column. However, the contractor shall verify pressure of gas in building. Contact utility-locating service for area where Project is located. The Utility provider is UGI Utilities Inc. who can be reached through their Technical Sales Specialist, Jason R Shirk at (484) 256-5719 or jshirk@ugi.com.
- B. Perform site survey, research public utility records, and verify existing utility locations.
- C. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect no fewer than 15 days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Architect's written permission.
 - 3. Natural gas is used to power the emergency generators. Interruption of the NG service shall be at times agreeable to the government's safety management personnel.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

- B. Material Group: 1.1.
- C. End Connections: Threaded or butt welding to match pipe.
- D. Lapped Face: Not permitted underground.
- E. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
- F. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

2.02 JOINING MATERIALS

- A. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded

2.03 MANUAL GAS SHUTOFF VALVES

- A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 - 1. CWP Rating: 125 psig.
 - 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 - 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- C. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 - 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
 - 2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.04 NATURAL GAS METERS

- A. Basis of Design Manufacturer: Onicon F-5500 Inline Thermal Mass Flow Meter. See 220519 – "METERS AND GAGES FOR PLUMBING PIPING."
1. Inline style meter capable of providing direct mass flow measurement of natural gas. Include display with keypad for user interface.
 2. Classification: Class 1 / Division I explosion proof.
 3. Accuracy: 1%.
 4. Turndown Ratio: 100:1 minimum but comply with 220519.
 5. Calibration: NIST traceable.
 6. Connections: Flanged.
 7. Output: 4-20 mA pulse or as best utilized by the BMS contractor. Coordinate interface/output for building management network with the mechanical contractor.

2.05 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
1. Manufacturers: Subject to compliance with specified requirements, manufacturers

offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:

- a. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. Hart Industries International, Inc.
- d. Jomar International Ltd.
- e. Matco-Norca, Inc.
- f. McDonald, A. Y. Mfg. Co.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- h. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Pressure Rating: 125 psig minimum at 180 deg F.
- c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:

- a. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. Matco-Norca, Inc.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- e. Wilkins; a Zurn company.

2. Description:

- a. Standard: ASSE 1079.
- b. Factory-fabricated, bolted, companion-flange assembly.
- c. Pressure Rating: 125 psig minimum at 180 deg F.
- d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: 150 psig.
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.

- e. Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine existing natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Correct unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

3.03 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in equipment rooms and service areas or above ceilings as indicated on drawings.
 - 1. The gas meter in the L&I building will be installed above the ceiling in room outside of which is the Utility Provider's gas meter.
 - 2. The gas meter in the H&W building shall be installed in the room housing the emergency generator.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Locate valves for easy access.
- G. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Verify final equipment locations for roughing-in.

- K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- M. Conceal pipe above ceilings unless indicated to be exposed to view.
- N. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- O. Where pipe must be extended and branches must be disconnected and reconnected outside the required straight pipe lengths, connect branch piping from top or side of horizontal piping.
- P. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- Q. Do not use natural-gas piping as grounding electrode.

3.04 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.05 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- C. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
 - 3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
 - 4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.06 CONNECTIONS

- A. Connect to gas meter to building's automation system for real-time monitoring, totalization, data manipulation and energy conservation initiatives.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

3.07 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

3.08 PAINTING

- A. Paint exposed, interior metal piping within 20 feet of new meter, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex (low sheen) .
 - d. Color: Yellow.
 - 2. Alkyd System: MPI INT 5.1E.
 - a. Prime Coat: Quick-drying alkyd metal primer.
 - b. *For a Premium Grade system, "MPI Manual" requires intermediate coat; delete*

intermediate coat for a Custom Grade system.

- c. Intermediate Coat: Interior alkyd matching topcoat.
- d. Topcoat: Interior alkyd (eggshell).
- e. Color: Yellow.

- B. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.09 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 5 PSIG

- A. The pressure in the subject buildings is regulated to 7 inches water column. Each piping system has a pressure relief set to 14 inches water column that is vented at the building exterior.
- B. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- C. Aboveground, distribution piping larger than NPS 1 shall be the following:
 - 1. Steel pipe with steel welding fittings and welded joints.

3.10 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 - 1. Two-piece, full -port, bronze ball valves with bronze trim.
 - 2. Bronze plug valve.

3.11 VALVE INSTALLATION

- A. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- B. Install metal shutoff valves upstream from meters. Install dielectric fittings downstream from service meters.

END OF SECTION

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SECTION 230000 - MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. All provisions of the "Instructions to Bidders", "Conditions of the Contract", "General Conditions", "Special Conditions", and Division 1 of the General Specifications as set forth in the General Construction Specifications and the applicable work in the "Mechanical Requirements Section" shall govern the work under the contract.
- B. The Contractor shall provide all the items, articles, materials, operations, or methods listed mentioned or scheduled on the Drawings and/or specified herein, including all labor, materials, equipment and incidentals necessary and required for their completion. The complete installation as a whole shall be left ready for satisfactory operation.

1.03 SCOPE

- A. Requirements specified herein shall govern applicable portions of Mechanical (Division 23) Work sections; hereinafter referred to as Mechanical Sections, whether so stated therein or not.
- B. The Contractor shall lay out their own work and assume responsibility for all lines elevations, inverts and measurements of work executed by them under the contract. they shall exercise every precaution to verify figures shown on the drawings before laying out work and shall be responsible for any error resulting from their failure to exercise such precautions.
- C. Where items specified in Mechanical or Electrical Sections conflict with requirements in this section, the former shall govern.

1.04 ABBREVIATIONS

- A. Following is key to abbreviations used in mechanical work:

A-C	Alternating Current
A, Amp	Ampere
AOW	Area of Work
BHP	Brake Horsepower
BTU	British Thermal Unit
C to C	Center to Center or on Centers
CFM	Cubic Feet Per Minute
C-P	Chrome Plated
Cu.In.	Cubic Inch
Cu.Ft.	Cubic Foot
Cu.Yd.	Cubic Yard

DB	Decibel
D-C	Direct Current
1.	Degree (angle)
2.	Diameter
F	Degree Fahrenheit
FPM	Feet Per Minute
F&T	Float and Thermostatic
B.	
or '	Foot
GAL	Gallon
GPH	Gallons Per Hour
HG	Mercury
HP	Horsepower
HR	Hour
IBBM	Iron Body Bronze Mounted
IN or "	Inch
IPS	Iron Pipe Size
KW	Kilowatt
KWHR	Kilowatt Hour
LB	Pound
Lin.Ft.	Linear Foot
L-P	Low Pressure
Max	Maximum
M&E	Mechanical and Electrical
Min	Minimum
M-P	Medium Pressure
N-P	Nickel Plated
OS&Y	Outside Stem and Yoke
OZ	Ounce
PRV	Pressure Reducing Valve
PSI	Pounds Per Square Inch
RPM	Revolutions Per Minute
Sec	Second
Sq.Ft.	Square Foot
Sq.In.	Square Inch
SP	Static Pressure
STD	Standard
SWP	Steam Working Pressure
TEMP	Temperature
WWP	Water Working Pressure

1.05 REFERENCES

- A. References to standards, codes, specifications or recommendations shall mean the latest edition of such publications adopted by the state and published at date of invitation to submit proposals.
- B. Reference to technical societies, trade organizations or governmental agencies is made in mechanical and electrical work sections with the following abbreviations.
- | | |
|--------|---|
| AGA | American Gas Association |
| AIEE | American Institute of Electrical Engineers |
| ASA | American Standard Association |
| ASHRAE | American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. |
| ASME | American Society of Mechanical Engineers |

ASRE	American Society of Refrigerations Engineers
ASTM	American Society for Testing Materials
AWWA	American Water Works Association
BOCA	Building Official Code Administrators
CBM	Certified Ballast Manufacturer's Association
CMA	Convactor Manufacturer's Association
CRSI	Concrete Reinforcing Steel Institute
CSD	Commodity Standards Division, US Dept. of Commerce
ETL	Electrical Testing Laboratories
HPACCNA	Heating, Piping & Air Conditioning Contractors National Association
IBR	Institute of Boiler & Radiator Manufacturer's
IPCEA	Insulated Power Cable Engineers Association
IUHA	Industrial Unit Heater Association
NBFU	National Board of Fire Underwriters
NBS	National Bureau of Standards
NEC	National Electrical Code (NFPA Pamphlet No. 70)
NEMA	National Electrical Manufacturer's Association
OSHA	Occupational Safety and Health Act
UL	Underwriters Laboratories, Inc.

- C. Installation shall conform to any referenced standards or codes except as directed otherwise in writing by the authority having jurisdiction. It is the contractor's responsibility to procure any codes or standards required for conformity.

1.06 DEFINITIONS

- A. Following definitions of terms and expressions used in mechanical sections are in addition to listing given in Supplementary General Conditions.
1. "Provide" shall mean "furnish and install".
 2. "Herein" shall mean the contents of a particular section here this term appears.
 3. "Install" shall mean furnish and install unless otherwise noted on the drawings.
 4. "Indicated" shall mean "indicated on contract drawings.
 5. "Section" shall mean one of the following portions of mechanical specifications:
 - a. Plumbing and Drainage
 - b. Heating, Ventilation & Air Conditioning
 - c. Fire Protection Work
 6. "Subsection" shall mean portions of Sections as listed under "Index" at the beginning of each Section.
 7. "Concealed" where used in connection with insulation and painting of piping ducts, and accessories, shall mean that they are hidden from sight, as in trenches, chases, furred spaces, pipe shafts or hung ceiling.
 8. "Exposed" where used in connection with insulation and painting of piping ducts, and accessories shall mean that they are not "Concealed" as defined herein above.
 9. "Piping" includes in addition to pipe, also fittings, valves, hangers, and other accessories which comprise a system.
 10. "Three-valve by-pass" includes one globe valve for throttling, two gate valves for shut-off, pipe and fittings.
 11. "Plumber" shall mean the Contractor or subcontractor for Plumbing, and any other subcontractors employed by the Plumbing Contractor.
 12. "Electrician" shall mean the Contractor (or subcontractor) for Electrical Work.

13. "Heating Trade" or "Contractor" or "Mechanical Contractor" shall mean the Contractor or subcontractor for Heating, Ventilation Work, Air Conditioning Work, Sheet Metal Work, Controls (Building Automation) Work and any other subcontractors employed by the Heating Contractor. All controls work shall fall under the auspices of the Mechanical Contractor.
14. "Singular Number". In all cases where a device or part of the equipment or system is herein referred to in the singular number it is intended that such reference shall apply to as many such items as are required to complete the installation.
15. "Remove" shall mean "disconnect and remove" and cap that part of the subject system to remain so that it is water, steam, air or gas tight.
16. "Owner, "Government" or "Department" shall mean the Commonwealth of Pennsylvania as represented by the Department of General Services and the Capitol buildings' facilities management.

1.07 DRAWINGS, INSTRUCTIONS

- A. Contract drawings for mechanical work are in part diagrammatic, intended to convey the scope of work and indicate general arrangement of equipment, conduits, piping and approximate sizes and locations of equipment outlets. Mechanical trades shall follow these drawings in the general layout/locations of their work, consult general construction drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed. For meter installation, additional offsets and transitions will be required to meet the manufacturer's installation requirements including the required straight pipe lengths necessary for repeatable, accurate measurements by the installed meters. Such offsets, transitions and installation of additional pipe shall be provided at no increase to the contract sum and the changes shall be shown on shop drawings generated by the contractor.
- B. Where job conditions require reasonable changes as indicated locations and arrangement, make such changes without extra cost to the Department. This is not to be construed as to permit redesigning of the various systems.
- C. Where new pipe is shown on drawings as replacement for existing pipe or to extend the piping arrangement to effect the upstream and downstream straight pipe lengths recommended by the meter manufacturer(s), the pipe size shall be the same as the meter size. No transitions of pipe size shall be permitted immediately before nor after the meter.
- D. Additional and supplementary drawings may, from time to time, be furnished and the same when made, are to constitute a part of the original contract. These drawings will be made to clarify the contract drawings and will not depart materially therefrom.

1.08 CODES ORDINANCES AND REGULATIONS

- A. Nothing contained in this specification or shown on the drawings is intended to conflict with the codes, laws, ordinance, rules or regulations of Federal, State, or Local Municipal Governmental Authorities having jurisdiction over the premises, including the Pennsylvania Department of Labor and Industry, the Pennsylvania Department of Environmental Resources, Pennsylvania Act (HB) 287, the National Board of Fire Underwriters Inspection Agency and the Owners Insuring Agency. All such codes, laws, ordinances, rules and regulations are hereby incorporated and made a part of these specifications. Fixtures, appliances and equipment which are subject to UL tests shall bear such approval. All work performed on this project and all equipment furnished for this project shall be in conformance with the regulations and requirements of the Occupational Safety and Health Act (OSHA).

- B. Should any change in the drawings and/or specifications be required to conform to the codes, ordinances, regulations or laws mentioned above, the Architect/Engineer shall be notified prior to the time of submitting bids. After signing of the Contract, each Contractor will be responsible for the completion of all work necessary to meet the above mentioned requirements without additional expense to the Owners.
- C. Contractor shall obtain and pay for all permits, inspections test and certificated relating to their work as required by any of the foregoing Authorities and all Utility Companies as applicable. All certificates shall be delivered to the Architect/Engineer and become the property of the Owner.
- D. The contractor shall contact the steam utility, Cordia Energy for any steam shutdowns required. Even if the contractor can isolate a steam system without the assistance of the Utility, the Utility shall be contacted in every case so that the reduced load on the steam plant can be regulated.
- E. Observe such rules and regulations as may be instituted by the Owner, Architect, Engineer, of their representatives affecting the conduct of employees, and the use and safeguarding of property.

1.09 VISIT TO SITE

- A. Before submitting a proposal, bidders shall carefully examine specifications and drawings, visit site of proposed work and fully inform themselves as to all existing conditions and limitations to be met, and shall include in their proposal a sum to cover cost to meet all existing conditions and limitations as well as cost of items included in these specifications.
- B. Should any discrepancies occur between existing conditions and drawings and specifications, they shall be immediately reported to the Engineer for clarification before bids are submitted. Submissions of a bid shall be considered conclusive that bidder has visited the site of proposed new work and is familiar with conditions to be met in execution of work by these specifications.
- C. Failure to a bidder to visit the site shall not in any way relieve them (successful bidder) from meeting any condition that may have to be met for a complete and satisfactory installation of mechanical requirements, and performance of all work, even though such conditions are not particularly mentioned herein.

1.10 EXISTING CONDITIONS TO BE VERIFIED

- A. The data so indicated or inferred to as existing conditions are not intended as representations or warranties of accuracy of construction and existing conditions.
- B. The data is made available for the convenience of the Contractor. The Contractor shall make all necessary additional field surveys and check all existing conditions prior to submitting their proposal at no cost to the Owner and with the Owner's approval.
- C. The exact location of utilities and services is not guaranteed nor is there any guarantee that all existing utilities, services, shafts, structures, functionally or abandoned are shown.
- D. Pipe sizes and pressures in pipes shall be verified in the field before ordering and purchase of meters.
- E. The Contractor shall verify in the field all dimensions, structures, services whether or not shown on the drawings. The Contractor shall field measure all conditions at the site and be

responsible for their correctness. No extra charge or compensation will be allowed on account for any difference between actual dimensions and any measurements indicated on drawings. Any difference found shall be reported to the Architect/Engineers and Owner in sufficient time for their consideration and direction before proceeding with the work involved.

1.11 LINES AND GRADES

- A. The Contractor shall lay out their work and be responsible for lines, elevations, measurements, required for installation of their work.

1.12 OBJECTIONABLE NOISE AND VIBRATION

- A. Mechanical equipment shall operate without objectionable noise and/or vibration as determined by the Department.
- B. If objectionable noise or vibration is produced and transmitted to occupied portions of building by apparatus, piping, ducts, or other parts of mechanical work, due to poor workmanship, omission of vibration isolators, shock absorbers, etc. the Contractor involved shall make necessary changes and additions, as approved, without cost to the Owner.

1.13 EQUIPMENT DESIGN AND INSTALLATION

- A. Uniformity. Unless otherwise specified, equipment or material of same type classification, used for the same purpose shall be products of the same manufacturer. All material shall be new and of the latest design of manufacturer providing equipment or material.
- B. Design. Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ASME, AIEE, or other applicable technical standards, suitable for maximum working pressure and shall have neat and finished appearance.
- C. Installation. Erect equipment in neat and workmanlike manner; align, level and adjust for satisfactory operation; install so that disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made only after obtaining approval from Architect and Engineer.

1.14 PROTECTION OF EQUIPMENT AND MATERIALS

- A. Following is in addition to Protection of Work and Property, Conditions of Contract:
 - 1. Responsibility for care and protection of mechanical work rests with respective contractor until it has been tested and accepted.
 - 2. After delivery, before and after installation, protect equipment and materials against theft, injury and damage from all causes
 - 3. Coat polished or plated metal parts with Vaseline immediately after installation.
 - 4. Protect equipment outlets and pipe, conduit openings with caps.
 - 5. Protect existing equipment which is to remain.

1.15 HANDLING OF EQUIPMENT AND MATERIALS

- A. Each Contractor shall receive, properly house, handle, hoist, deliver to proper locations, equipment and other material required for their contract.

1.16 COOPERATION AND COORDINATION

- A. The Contractors shall cooperate and confer with each other as to locations of their materials and equipment before erecting work to avoid interference as much as possible and in such a manner that will in no way retard progress of construction. In instances where interferences develop the contractors shall relocate their work as required by the Government and the Professional regardless of which work was installed first.
- B. Before installing piping, conduit and equipment check drawings all drawings, visit the site and make accurate layout of piping, conduit and equipment. Produce and submit shop drawings of the specific intended work. Where interferences may appear and departures from indicated arrangements are required, consult with other trades involved and the Government, come to agreement as to changed locations and elevations of piping, conduit and equipment, obtain approval of proposed changes. Submit copies of final layout to other trades and the Government for checking and coordinating with their work so that grouped pipes, conduit, ducts, will not interfere with each other or with full swing of doors, and will leave headroom as indicated.
- C. In crowded locations where composite cross sections of piping and conduit are not indicated, contractors shall submit shop drawings which will include composite cross sections of piping and conduit of various trades in order to avoid interference during construction.
- D. The contractor shall coordinate work such that no piping equipment is installed in the dedicated space directly above electrical panels, switchgear, equipment, etc. As part of field coordination, revise routing of piping, etc. as required, to eliminate foreign piping above electrical equipment.

1.17 SUPERINTENDENCE

- A. Contractor shall give their personal superintendence to the work or have a competent working superintendent, satisfactory to the Government and the Professional, on site at all times during construction with authority to act for him. They shall provide an adequate organization for proper coordination and expediting of all work.

1.18 SCAFFOLDING

- A. The Contractor shall furnish and install scaffolding ladders and runways required in connection with their work.

1.19 SAFETY

- A. The Mechanical Contractor shall furnish and place necessary guards for the prevention of accidents. They shall provide and maintain any necessary construction required to secure safety to life or property.

1.20 ELECTRICAL WIRING

- A. In general, all electric power circuit wiring will be furnished and installed by the Electrical Contractor. Power circuit wiring shall encompass all work up to and including electrical connections through the disconnect switch, motor started or equipment terminals and etc. as indicated on the electrical drawings. All motors and other mechanical equipment will be furnished and installed by the respective contractor.
- B. With the exception of control and data wiring as shown or noted on the drawings to be installed by the Electrical Contractor, each contractor shall furnish and install their own low voltage control wiring complete in every respect, including 120 volt nominal power circuits from nearby electrical panels to control panels of transformers for control voltage wiring. Each contractor shall also furnish and install their own motor starters and other controls or actuating devices as required. All wiring shall be in conduit. Control wiring shall be in blue painted EMT.
- C. The Electrical contractor will be held responsible for the safe and proper operation of all motorized equipment to the extent that it is affected by their work and shall make all tests required to assure that such operations is achieved.

1.21 PATCHING

- A. The Contractor will do all patching of concrete, drywall and other surfaces necessary to complete their work. All patching shall match the existing surfaces. Patching shall be done by personnel skilled in the trade. Painted surfaces shall be repainted to a natural stop (inside or outside corner, chair rail, or other reasonable natural stop).

1.22 CONCRETE WORK

- A. Each Contractor shall provide all materials, equipment, labor and supervision necessary to construct concrete work indicated on the drawings or hereinafter specified for foundations, piers, pedestals, cradles, duct envelopes or similar items. All concrete shall be ready mixed conforming to ASTM Designations C-94-65.
- B. Material shall be used as follows:
 - 1. Portland Cement - ASTM Designation C150.
 - 2. Air Entraining Portland Cement - ASTM Designation C175.
 - 3. Strength, Proportion and Mix of Concrete - the proportion of cement, aggregate, and water to attain required plasticity and compressive strength after 28 days shall be as follows: 3300 lbs. concrete shall consist of 1 part Portland Cement - 1-1/2 parts fine aggregate and 2-1/2 parts of coarse aggregate size 2B. Use minimum of 7 bags cement per cubic yard and a maximum of 6 gallons of water per bag of cement.
 - 4. Cement Grout - 1 part Portland Cement and 1 part graded sand of approved consistence.
- C. Concrete housekeeping pads and pipe/valve support pillars shall be reinforced with welder wire mesh. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement. Provide at least four #4 rebar dowels but at least one dowel every 18 inches. Dowels shall extend from at least a 3 inch embedment into the existing concrete floor to within one inch of the top surface of the poured pad or support structure.

1.23 CUTTING, PATCHING, RESTORING

- A. All cutting and patching required in existing constructions shall be done by the respective Contractor concerned. Patching shall also include repairing walls, floors, ceilings, etc. where existing equipment has been removed. No Contractor shall do any cutting that may impair the strength of the building construction. No holes, except for small screws, may be drilled in beams or other structure members, without obtaining prior approval. Each Contractor shall restore work of other contractors in connection with installation of work of Mechanical trades due to their errors, defective or ill-timed work or tardiness on the part of such contractors to designate sizes and locations to the General Contractor in sufficient time shall be paid for by the respective contractor.

1.24 TEMPORARY OPENINGS

- A. Holes provided in General Construction work to permit installation of lines for temporary mechanical services will, after removal of such lines, be patched by the Contractor for whom the holes were provided.

1.25 REMOVAL OF RUBBISH

- A. Periodically, and at the completion of the work contemplated under these specifications, each Contractor shall remove from the building and site all rubbish and accumulated materials of whatever nature not caused by other trades, and shall leave the work in a clean, orderly, and acceptable condition. In addition, at the conclusion of the Project, before the work is deemed ready for final inspection, each Contractor shall clean all items of paint splashes, grease stains, dust, finger marks, and all other unsightly marks.

1.26 TEMPORARY SERVICES

- A. Temporary services for construction purposed are specified under Conditions of Contract. Temporary services for building operation are specified under the respective specification sections as required.

1.27 GUARANTEE

- A. In addition to the requirements listed herein before and stated in the individual work sections, the respective contractor must guarantee all materials and apparatus installed by them to be free from all defects in construction and workmanship for a period of one (1) year after acceptance of the work.

1.28 MACHINERY AND EQUIPMENT ACCESSORIES

- A. Lubricating devices. Provide oil level gauges, grease cups, grease gun fittings for machinery bearing as recommended by machinery manufacturer, where lubricating means are not easily accessible, extend to accessible locations. Furnish all grease gun fitting of uniform type.
- B. Belt guards. Provide guards to enclose belts, pulleys, sheaves, on belt driven equipment. Construct of galvanized expanded or perforated sheet steel, or 1" mesh wire screen, in angle

frame with steel angle or channel mounting supports, make guard easily removable for access to belt, pulley or sheave. Conform to codes or regulations of agencies having jurisdiction. Paint prime and finish coats.

1.29 FIRE STOPPING SYSTEM

- A. The Contractor shall furnish and install all labor and materials necessary for the completion of fire stopping as required for all pipe, tube, ductwork, conduit, cable, wiring, cable trays or similar through-penetrations of fire resistive walls, floors, floor-ceiling or roof-ceiling assemblies. (See Architectural drawings for fire ratings).
- B. All material and application procedures shall have been tested and classified by UL and approved by Factory Mutual for the assembly.
- C. The Fire Stopping System shall have been tested in accordance with the procedures of ASTM E814-81 (UL 1479-1983) and shall be UL classified and Factory Mutual approved as a Through-Penetration Fire Stop System.
- D. Contractor shall submit manufacturer's specification and installation instructions for type of fire stopping required including data showing compliance with requirements.

1.30 ACCESS DOORS

- A. Unless otherwise specified the respective contractor shall furnish access panels for concealed valves, expansion joints, valves, traps, strainers, dampers and other parts requiring assembly for operation and maintenance to General Construction Contractor who shall install all access panels.
- B. Access panel size shall be as directed; when not indicated, make panel 18" x 18" minimum or larger as directed or required.
- C. Access panels and doors in ductwork are specified in the Ductwork Section under Heating and Ventilation.
- D. Frames shall be 16 gauge steel. Doors shall be 14 gauge flush type with concealed hinges and cylinder locks master-keyed to building systems, specified under "Finishing Hardware".
- E. Access panels for use in plastered surfaces shall have 22 gauge casing beads and be designed to finish flush with walls. Style K as manufactured by Milcor, or approved equal.

1.31 SPARE PARTS

- A. Each contractor shall furnish spare parts for equipment furnished by them as follows:
 - 1. These spare parts are supplementary to the ones specified under individual equipment units, where there is duplication or conflict, the individual unit requirement shall govern.
 - 2. Deliver spare parts wrapped or boxed and marked or tagged for identification and reordering, obtain receipt from Owner's authorized representative.

1.32 TOOLS

- A. Each contractor shall furnish tools required for their equipment as follows:
 - 1. One set of special wrenches, tools, required to operate, adjust, repair installed equipment as recommended by manufacturer or such equipment.
 - 2. One dozen special keys, wrenches, required to adjust grilles and thermostats.

1.33 PAINTING AND FINISHING

- A. Except as specified herein the finish painting of all Mechanical work within the building shall be by each respective contractor.
- B. Piping and Equipment Color Coding shall be by the respective Contractor as set forth under their respective sections of the specifications or as noted on the drawings.
- C. The respective Contractor shall clean all piping, insulation, conduit ducts and equipment of all plaster, cement, dirt and debris. Sizing of the insulation shall be performed by the insulation applicator. The Contractor shall provide protective finish on all ferrous materials installed by him. Hangers, rods, stands and similar devices that are not factory finished shall be covered with one coat of Rust-Oleum paint or approved equal of color selected to prevent oxidation.
- D. All equipment provided with a factory finish shall not be painted. Primer coat on equipment is not considered a factory finish.
- E. All painting shall consist of two coats of different tint.
- F. All items of equipment rusted or marred even though factory finished shall be repainted.
- G. Touch-up painting of work marred by respective trades shall be done by the respective Contractor to the satisfaction of the Architect/Engineer. Respective trades shall bear all costs involved.

1.34 DATA FOR MANUALS

- A. In addition to the catalog data and shop drawings submitted for approval, each Contractor shall furnish, for use in preparing operating and maintenance manuals, three final and corrected copies of all catalog data, shop drawings, performance curves and rating data, spare parts lists and manufacturer's operation and maintenance data applicable to the equipment furnished. The Contractor shall suitably bind and index said material and it shall be delivered to the Owner not less than 30 days before the start of operation or any instructions period hereinafter or herein before specified. This shall include calibration data for metering equipment that was made at the time the systems are put in service.

1.35 INSTRUCTION OF EMPLOYEES

- A. Each Contractor shall furnish without additional cost to the Owner, the services of competent instructors, who will give full instruction in the care, adjustment and operation of all parts of the Mechanical Equipment to the employees of the Owner who are to have charge of the equipment. Each instructor shall be thoroughly familiar with all parts of the installation on which

they are to give instruction and shall be trained in operating theory as well as in practical operation and maintenance work. Factory trained instructors shall be employed wherever they are available. Instruction shall be given during the regular work day after the building has been accepted and turned over for regular operation. If significant changes or modifications in equipment are made under the terms of the guarantee, additional instructions shall be provided as may be necessary to acquaint the operating personnel with the change or modifications.

- B. In addition to the instruction period mentioned above, the Contractor shall demonstrate the Automatic Temperature Control cycle at every piece of controlled equipment and instruct the maintenance personnel on all Automatic Temperature Control Equipment.

1.36 WIRE GAUGE

- A. The sizes of conductors and thickness of metals shown on the drawings or specified herein, shall be understood to be American Wire Gauge for copper wire and United States Gauge for metals.

1.37 TESTS

- A. Test for Systems are specified under the respective specification sections as required.

1.38 RESPONSIBILITY FOR DAMAGE

- A. Each respective Contractor at their own expense shall make good to the Department's satisfaction any damage to their or any work incurred by the action of the elements or any other cause due to neglect on the part of the Contractor or their workmen.

1.39 EQUIPMENT FOUNDATIONS

- A. Each respective Contractor shall provide all concrete foundations required for equipment furnished under these specifications unless otherwise noted on the drawings or in the specifications.
- B. All foundations shall be built to templates and reinforced as required by the load to be imposed upon them.
- C. Each respective Contractor shall furnish shop drawings showing size and location, in detail, for the General Contractor of all foundations for equipment, for approval before any construction is begun, and shall assume all responsibility for the size and location of all foundations.

1.40 MISCELLANEOUS IRON WORK

- A. Each respective Contractor shall furnish and install necessary structural supporting steel for supports for air handling units, ductwork, all suspended equipment, piping, lighting fixtures and all other equipment furnished by them requiring support steel and for equipment as noted on the drawings.

1.41 WALL OPENINGS

- A. Wall openings and flashing for piping, vents, and other items which penetrate the walls and roof shall be by each respective Contractor. Unless otherwise noted counter-flashing required for all items shall be by each respective Contractor.

1.42 EQUIPMENT PIPING CONNECTIONS

- A. Each piece of equipment that may have to be removed from the system or opened up for repair, such as control valves, air handling units, pumps, boilers and expansion joints shall be provided with union or companion flanges and isolating valves to permit such removal without draining or shutting down the system.

1.43 PIPING IN UNHEATED AREAS

- A. Where it is indicated on the drawings to run piping where there is an adjacent unheated area, piping shall be run between the heated space and the building insulation to prevent freezing.

1.44 EXISTING CONDITIONS (REMOVAL OF ABANDONED MATERIALS AND/OR EQUIPMENT)

- A. Unless otherwise noted on the drawings, the Contractor shall remove from their present locations in the renovated areas, and from the premises, all existing equipment not applicable to the new installation or as indicated on the drawings and required to accomplish the new installation.
- B. The Contractor shall remove all existing equipment, piping, ductwork and all other items not applicable to the revised installation and as indicated on the drawings.
- C. Unless otherwise noted on the drawings, or in the specifications, all existing equipment to be removed is to become property of the Contractor and shall be removed from the existing building and premises and disposed of by the Contractor.
- D. All abandoned piping, etc, which run concealed shall be cut off below floor, in wall or above ceiling, as required. Where a utility company's equipment is involved, Contractor shall notify company of same.
- E. The Contractor shall disconnect any service to this equipment, prior to removal, under this Contract and cap or plug same as required to permit operation.
- F. See Cutting, Patching, Restoring as herein before specified.
- G. The Contractor shall visit the site and shall visually observe and note existing conditions that they are to contend with, for the purpose of preparing their bid.

1.45 COST BREAKDOWN

- A. This Contractor shall furnish a complete "Contract Cost Breakdown Sheet" for each and every item provided by them under their contract, and submit same to Architect/Engineer for approval.

- B. The cost breakdown shall be broken down into unit cost, such as, cost per lineal foot of one (1) inch pipe installation, cost per lineal foot of two (2) inch pipe, etc.

1.46 SUBSTITUTIONS

- A. During the bidding period, the Architect/Engineer will consider written requests from prime bidders/Contractors for substitutions, if received at least ten (10) days prior to bid date; requests received after that time will not be considered.
- B. Request for Substitutions must be accompanied with manufacturer shop drawings and/or catalog data describing the product and that complies with the plans and specifications in all respects.
- C. Within 30 days after date of Contract, the Engineer will consider formal requests from Contractor for substitution of products in place of those specified as follows:
 - 1. Such requests shall, state, in writing, the amount in dollars by which the Contract Sum would be reduced in case of approval of such substitution.
 - 2. The Contractor assumed all responsibility for adjustments in or to, adjacent materials caused by use of the substitute materials, and for performance of all substitution with respect to any guarantees.
- D. Contractor shall submit Request for Substitution, and shall include in the request the following:
 - 1. Complete data substantiating compliance of proposed substitution with Contract Documents.
 - a. Product identification, including manufacturer's name and address.
 - b. Manufacturer's literature and data.
 - 1) Product description
 - 2) Performance and test data
 - 3) Reference standards
 - c. Samples.
 - d. Name and address of similar projects on which products were used and date of installation.
 - 2. Itemized comparison of proposed substitution with product specified.
 - 3. Data relating to changes in construction schedule.
 - 4. Relation to separate contracts.
 - 5. Accurate cost data on proposed substitution in comparison with product specified.
- E. In making a Request for Substitution, the Bidder/Contractor represents that:
 - 1. They have personally investigated proposed product and determined that it is equal or superior in all respects to that specified.
 - 2. The project goals will be achieved seamlessly.
 - 3. They will provide the same guarantee for substitutions as for product or method specified.
 - 4. They will coordinate installation of accepted substitution into work, making such changes as may be required.
 - 5. They waive all claims for additional costs related to substitution which consequently become apparent.

6. Cost data is complete and includes all related costs under their Contract, but excludes:

- a. Costs under separate contracts.
- b. Engineers redesign fee.

F. Substitutions will not be considered if:

- 1. They are indicated or implied on shop drawings or project data submittals without formal request submitted in accordance with the above.
- 2. Acceptance will require revision to Contract Documents.

1.47 INTERRUPTION OF SERVICES

- A. The Contractors attention is called to the fact that the existing facilities must remain in operation during the construction period. In view of this, the Mechanical Contractor shall maintain services for these facilities until such time that the new services are installed, energized and ready for connecting.
- B. All work shall be done in such time and manner as will least interfere with the maintenance and operation of all related or affected existing mechanical systems. Provisions must be made to permit the use of all systems at all times by the Owners. Any interruptions to systems required to perform the work shall be pre-arranged, in advance, with the Owner. The Contractor shall provide temporary services as required to accomplish this.
- C. The work that is to be completed in spaces that are normally occupied by building personnel that are not part of the facilities staff shall be executed outside the normally occupied hours. This includes offices and mail rooms that are not dedicated to building systems and services.

1.48 TRAINING OF STAFF

- A. The Contractor shall arrange with the manufacturer representative, of the various systems installed, who shall conduct complete training programs for the Owner's staff personnel to familiarize them with the operation and preventative maintenance of the system.
- B. The training program shall consist of at least three (3) full four (4) hour days of instructions. Time and dates of the training programs shall be coordinated with the Owner.

1.49 TEMPORARY WATER

- A. The Contractor shall provide and maintain all temporary water and all piping and connections as required for construction purposes and pay for all water consumed. Conform to the regulations of OSHA, Department of Labor, Chapter 12, Part 1926, Subpart D, Section 1926.51.

1.50 TEMPORARY HEAT

- A. The Contractor shall provide and maintain temporary heat when required to protect dry work during cold weather. When outside temperature falls below 40 degrees F during day and night, and work has progressed to a point where protection is required, or is requested by Architect/Engineer, the Contractor shall cover work and furnish sufficient heat to maintain a temperature of at least 50 degrees F within the building at all times.

- B. Obtain Architect/Engineer's approval for all temporary heating methods and equipment. No salamander's or open fires will be permitted; portable heating units similar to Herman Nelson may be used.
- C. The Contractor shall close up all openings with temporary enclosures to insure the adequate retention of heat.
- D. The Contractor has the option, at their expense, when the permanent heating system is installed, and in operation and subject to the prior approval of the Department, to energize the permanent heating system to maintain temporary heat as outlined above. When temporary heat is not longer required, they shall restore the permanent heating system to its original installed condition. All air filters shall be replaced at their expense.
- E. The Contractor shall pay for all fuel and electricity used by portable heaters and the permanent heating system until the date of Substantial Completion.

1.51 TEMPORARY SANITATION FACILITIES

- A. The Contractor shall provide and maintain toilet facilities and washing facilities for the use of workmen. The minimum number of facilities shall be in accordance with the regulations of OSHA, Department of Labor, Chapter 17, Part 1926, Subpart D, Section 1926.51. All facilities shall comply with the laws and ordinances. All toilet and washing facilities shall be located as directed by the Department. The Department may, but is not obligated to allow use of facilities on site.

1.52 TEMPORARY VENTILATION

- A. The Contractor shall provide temporary ventilation to remove from the building any excessive humidity, dangerous or noxious fumes, or particles suspended in the air, so that the work may be executed without interruption and under correct conditions, including required dryness for installation of the various materials. The Contractor shall provide all such equipment, pay all cost for their operation, including fuel, power, labor and surveillance during operations both in and out of normal working hours.

1.53 TEMPORARY MEDICAL SERVICE AND FIRST AID

- A. The Contractor shall provide and maintain medical services and first aid all in accordance with the regulations of OSHA, Department of Labor, Chapter 17, Part 1926, Subpart D, Section 1926.50.

1.54 OTHER SAFETY MEASURES

- A. The Contractor shall comply with all other applicable OSHA requirements for the safety in building construction which are not specifically mentioned in this section of the specifications.

1.55 TEST REPORT

- A. The Contractor shall, upon completion of Boiler installation, the contractor shall request the Pennsylvania Department of Labor and Industry Boiler Inspection to witness the Hydrostatic

testing of piping. The contractor shall complete the Labor and Industry Test Forms and submit same to the Department.

1.56 THIRD PARTY INSPECTIONS - MECHANICAL

- A. The Mechanical Contractor shall include in their bid monies for "Third Party Inspections" of all work, as required by the local municipality.
- B. Inspection work shall be done by an inspection firm licensed by the local municipality.

1.57 ELECTRIC POWER FOR AUTOMATIC TEMPERATURE CONTROL PANELS AND EQUIPMENT - PROVIDED BY AUTOMATIC TEMPERATURE CONTROL CONTRACTOR.

- A. Electric power 120v-1 Phase circuits for operation of all building automation control panels, and 120 volt power source for transformers supplying control and metering equipment (as required), and other low voltage transformers shall be wired, installed and obtained from the nearest 120v panel spare circuit by the automatic temperature control subcontractor in accordance with the electrical section of the project specification.

END OF SECTION 230000

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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 DEFINITIONS

- A. Existing Piping To Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.03 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Ratings and characteristics of supply circuit and required control sequence.
 - 2. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.01 INSTALLATION OF EXPANSION JOINTS - GENERAL

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.02 INSTALLATION OF PIPE LOOPS AND SWING CONNECTIONS

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least pipe fittings, including tee in main.

3.03 INSTALLATION OF SLEEVES - GENERAL

- 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 2-inch annular clear space between piping and concrete slabs and walls.
 - 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.
 - 3. Using grout or silicone sealant, seal space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.04 INSTALLATION OF METERS AND GAUGES

- A. Install thermowells with socket extending a minimum of 2 inches into fluid but at least one-third of pipe diameter and in vertical position in piping tees. Any thermal wells shall be installed outside the straight pipe length required pipe runs dictated by meter manufacturers to ensure accurate measurement.
- B. Install thermowells of sizes required to match thermometer or sensor connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.

- G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator and control system. Provide on main chilled water supply and return piping outside the up- and down-stream meter manufacturer's recommended straight pipe length.
- H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- I. Install remote-mounted pressure gauges on panel.
- J. Install valve and snubber in piping for each pressure gauge for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gauge for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.
- Q. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
 - 1. Replace pipe that is required to be "straight run" pipe by manufacturer to eliminate any tubercles, corrosion or other anomalies that may have formed over the course of service in other than new pipe.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Mount thermal-energy meters, displays, pressure transmitters, multivariable transmitters, secondary elements, computers and control panels on wall if accessible; if not, provide brackets to support meters.
- U. Install pressure gauges outside the required straight pipe lengths in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water meter.

3.05 CONNECTIONS

- A. Install meters and gauges adjacent to allow space for service and maintenance of meters, gauges, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.

- D. Connect thermal-energy meter transmitters to meters.
- E. Connect all transmitters, converters, electronic enclosures for all meters installed by the Mechanical, Electrical and Plumbing Contractors to the building automation system (building control/management system).

3.06 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.07 SLEEVES APPLICATION

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 - 1. Concrete Slabs above Grade:

3.08 THERMAL-ENERGY METER APPLICATION

- A. Thermal-Energy Meters for Chilled-Water Piping: Electromagnetic type.
- B. Thermal-Energy Meters for Steam Piping: Differential Pressure type.

END OF SECTION

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Meters
 - 2. Flow straighteners/conditioners.
- B. Report:
 - 1. Field Calibration activities and results.
 - 2. Startup calibration documentation for review/record.

1.03 SUMMARY

- A. Section Includes:
 - 1. Differential Pressure Meters for Steam
 - 2. Electromagnetic Meters for Chilled Water.
 - 3. Accessories and Installation.

1.04 WARRANTY

- A. One year for all metering devices.

PART 2 - PRODUCTS

2.01 DIFFERENTIAL PRESSURE METERS FOR STEAM

- A. **Basis of Design product steam: Rosemount 3051SFC-1C with four hole conditioning orifice plate.**
- B. Subject to compliance with specified requirements, manufacturer's products that may be incorporated into the Work include, the following or Government approved equivalents:
 - 1. ExactSteam V-Cone®Flowmeter.
 - 2. EMCO Flow Systems; a division of Spirax Sarco, Inc. STEEMCO Epsilon Flowmeter for Steam with flow conditioner. Of the three manufacturers, use of the EMCO product

(STEEMCO Epsilon Flowmeter) will required the greatest straight pipe lengths.

C. Features:

1. Equipped with multivariable transmitter.
2. Multivariable Transmitter shall be customized to obtain measurement combinations of differential pressure, static pressure, and process temperature. Engineered with built-in flow calculations for fully compensated mass flow measurements. Transmitter shall provide Direct Mass Flow Measurement for Saturated Steam.
3. Accuracy for saturated steam $\leq 2\%$ of reading. Mass flow accuracy shall be inside this tolerance over the range of the meter, including all errors associated with velocity measurement, temperature and/or pressure measurement, and density compensation.
4. Programmed and ready for use upon delivery or engage factory authorized representative to startup and program as necessary. The flow meter shall be programmed by the manufacturer or their authorized field agent for each specific application. Startup calibration shall be executed by the manufacturer's representative.
5. Integral density compensation to provide direct mass steam flow output.
6. Calculates mass flow corrected for density with real time calculations based on temperature measured by an integral sensor. Mass flow inferred from specified steam pressure or calculated externally to the flow meter will not be acceptable.
7. Sized by the manufacturer for each specific application and installed according to manufacturer's recommendations.
8. Provide a flow straightener for any DP orifice plate that does not employ a 4 hole conditioning plate.
9. Provide lateral and horizontal supports as required to minimize vibration at the meter location.
10. The pressure transducer shall be offset from the steam pipe with an adequate length of impulse piping to reduce the temperature at the transducer to no more than 200°F.
11. Each flow meter shall be individually calibrated at at least 5 selected points (and as recommended by the meter manufacturer to maximize accuracy) from 0-250 ft/s against the manufacturer's flow standards. The 4-20 signal from the transmitter shall in turn be received/conditioned/integrated as required to display the flow on the building control system.
12. The manufacturer shall provide a certificate of calibration for each meter.
13. The meter shall be provided with ANSI class 150 or class 300 flanges as required to meet system requirements.
14. The maximum operating temperature shall meet or exceed 600 F.
15. The flow meter body shall be constructed of stainless steel. The pressure transmitter shall include a weather-tight NEMA-4 aluminum electronics enclosure.
16. The meter shall display steam mass flow rate and mass flow total with an integral LCD display and support field programming of all parameters. If the pressure transducer is not capable of calculations based on all required input diameters a flow computer shall be provided that has a 4-20 mA output.
17. The meter shall also have integral diagnostics to verify installation conditions and the proper operation of the meter. The meter shall provide a loop-powered 4-20 mA output signal calibrated in direct mass flow rate units for connection to the Building Automation Systems (BAS/BMS) in each building. In addition, an integral pulse output for steam mass flow totalization shall be provided.
18. All outputs shall be linear with mass flow rate.

D. Remote Electronics Module:

1. Provide remote mount electronics option with 30 ft. factory cable and mounting bracket. Do not cut or splice the factory cable.

- E. Remote Auxiliary Display Module:
 - 1. Provide a Display Module for remote LCD indication of Mass Flow Rate and Total Mass. The indicators shall be housed in a wall mountable, minimum sized 6" x 6" x 4," steel NEMA-4 enclosure. Output signals for mass flow rate (4-20 mA) and total (pulse) shall be available at the display module terminal strip, for connection to the Central Control System (BMS/BAS). Provide 24 VAC input power to the display module (this version may not be loop-powered).
- F. A 24VDC power supply shall provide power to the Flow Meter.
- G. Provide a Network Interface compatible with the selected meter and the BAS/BMS in each subject building. The network interface shall transmit Mass Flow Rate and Total Mass data via a serial network conforming to one of the following protocols: BACnet, BACnet IP, JCI-N2 as appropriate for the subject BMS/BAS.
- H. Temperature sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within $\pm 0.15^{\circ}\text{F}$ (including the error from individual temperature sensors, sensor matching, input offsets, and calculations). Provide stainless steel hot tap thermowells with isolation valves for each temperature sensor. Temperature sensors shall also be acceptably strapped tightly to the outside of the steel steam pipe immersed in nonevaporating high temperature thermal conducting paste and covered with at least 4.5 inches of insulation.

2.02 ELECTROMAGNETIC METERS

- A. **Basis of Design Product: Ultra Mag by McCrometer**
- B. Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include the following or Government approved equivalent:
 - 1. Onicon Inc F3200 Inline
 - 2. Rosemount 8700 Series Inline
- C. Energy Measurement System: The entire Energy Measurement System shall be built and calibrated by the same manufacturer furnishing the meters, and shall consist of a flow meter, two temperature sensors, a meter, temperature thermowells, and all required mechanical installation hardware.
- D. The meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate, Supply Temperature and Return Temperature. Output signals shall be either serial network (protocol conforming to BACnet@/IP, JCI-N2, or Siemens-P1) and/or via individual analog and pulse outputs. Each meter shall be factory programmed for its specific application and shall be re-programmable using the front panel keypad (no special interface device or computer required).
- E. Temperature sensors: Temperature sensors shall be loop-powered current based (mA) sensors and shall be bath-calibrated and matched for the specific temperature range for each application. The calculated differential temperature used in the energy calculation shall be accurate to within $\pm 0.15^{\circ}\text{F}$ (including the error from individual temperature sensors, sensor matching, input offsets, and calculations). Provide stainless steel hot tap thermowells with isolation valves for each temperature sensor.

- F. Flow Meter: Refer to meter schedule. The flow meter shall be installed either in the supply or return pipe of the system to be measured following the manufacturer's instructions with particular attention to upstream and downstream straight pipe runs. In each case it is indicated in which pipe (supply or return) the meter is to be installed but the Contractor is at liberty to propose installation in the alternate pipe (return or supply) subject to the approval of DGS.
1. Inline (full bore) Electromagnetic Type: Provide an Electromagnetic Flow Meter complete with integral or remote electronics module. The electronics module shall include a backlit graphic display and keypad. Connections to the piping shall be ANSI class 150 flanges. The installing contractor is responsible for providing suitable mating flanges. The flow tube and the sensing electrodes shall be 316SS or the manufacturer's standard material. The liner shall be polypropylene or ebonite for low temperature service. Each flow meter shall be individually wet-calibrated and accurate to within $\pm 0.2\%$ of reading from 3 to 33 feet per second velocity. A certificate of calibration shall be provided with each flow meter. Output signals shall be 4-20 mA and programmable pulse. The flow meter shall be capable of measuring bi-directional flow. For installations in non-metallic pipe, install grounding rings between flanges. Each flow meter shall be factory programmed for its specific application, and shall be re-programmable using the integral keypad on the converter.

2.03 ACCESSORIES

- A. Wafer-style flow conditioner.
1. Designed to be installed between two ANSI class 150 or class 300 flanges.
 2. Specifically designed for use with the selected meter.
 3. The size of the straightener shall match the meter size.
 4. 304 or 316 Stainless Steel.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install meters in accessible locations to allow for meter removal. Where meters are located above hard ceilings or inaccessible locations install access panels to allow access to meters. Minimum access panel size shall be 24" x 24".
- B. Meters shall be installed in pipe of identical size to the meter.
1. Where meters are not the same size as existing pipe, demolish pipe on the upstream and downstream sides of the meter to the straight pipe length required by the meter manufacturer and replace pipe with a pipe size that matches the meter size. Use eccentric reducers on horizontal pipe with the flat side on the bottom of the pipe.
- C. To avoid start up delays due to fouling of devices foul with loosened slag/debris from disturbed existing pipe:
1. After cutting away the pipe where the meter and new pipe will be installed, and before installation, thoroughly clean the inside of the pipe on both the upstream and downstream sides of the meter location.
 2. Steam pipe shall be replaced to the extent of the manufacturer's recommended straight pipe length on both sides of the meter.

- D. Install meters according to manufacturer's instructions.
- E. The flow meter location shall meet the manufacturer's minimum upstream and downstream straight pipe run requirement. Install flowmeters with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
 - 1. Where required in connection with the meter manufacturer's recommended minimum upstream straight pipe length, a flow straightener / flow conditioner shall be provided. The straightener/conditioner shall be one that is manufactured by or specified by the meter manufacturer. Unless otherwise required by manufacturer, install flow straighteners at least two pipe diameters from the last obstruction fitting. Install meters downstream of straighteners/conditioners as specified in manufacturer's instructions.
- F. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- G. Install permanent indicators on walls or brackets in accessible and readable positions.
- H. Install connection fittings in accessible locations for attachment to portable indicators.

3.02 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Provide wiring between the meter transmitters and the building automation system.
- C. Locate thermowells for temperature sensors outside the required straight pipe length of meters on supply and return chilled water pipes.
- D. Provide a means to open, inspect and clean all sensing lines on DP meters.

3.03 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Run any startup and calibration subroutines that are part of the standard software/firmware package for each meter. Print report.
- C. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

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SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Bronze ball valves.
 - 2. Iron, single-flange butterfly valves.
 - 3. Iron gate valves.
 - 4. Chainwheels.
- B. Related Sections:
 - 1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.03 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.05 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves.

B. Non-rising stem gate valves are only acceptable if they have a means to indicate they are open or closed other than exercising the valve. With no such indication NRS valves shall be unacceptable.

C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

D. Valve Sizes: Same as upstream piping unless otherwise indicated.

E. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Hand lever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

F. Valves in Insulated Piping: With 2-inch stem extensions for chilled water and 4 inch for steam and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

G. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.02 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Conbraco Industries, Inc.; Apollo Valves.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Hammond Valve.
 - d. Lance Valves; a division of Advanced Thermal Systems, Inc.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE or TFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

2.03 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - b. Bray Controls; a division of Bray International.

- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Milwaukee Valve Company.
- k. NIBCO INC.
- l. Norriseal; a Dover Corporation company.
- m. Red-White Valve Corporation.
- n. Spence Strainers International; a division of CIRCOR International.
- o. Tyco Valves & Controls; a unit of Tyco Flow Control.
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

B. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Conbraco Industries, Inc.; Apollo Valves.
- c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- d. Crane Co.; Crane Valve Group; Jenkins Valves.
- e. Crane Co.; Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Flo Fab Inc.
- h. Hammond Valve.
- i. Kitz Corporation.
- j. Legend Valve.
- k. Milwaukee Valve Company.
- l. NIBCO INC.
- m. Norriseal; a Dover Corporation company.
- n. Red-White Valve Corporation.
- o. Spence Strainers International; a division of CIRCOR International.
- p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze.

2.04 BRONZE GATE VALVES

A. Class 150, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Kitz Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Powell Valves.
 - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - i. Zy-Tech Global Industries, Inc.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron.

2.05 IRON GATE VALVES

A. Class 250, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - d. Ends: Flanged.
 - e. Trim: Bronze.
 - f. Disc: Solid wedge.

- g. Packing and Gasket: Asbestos free.

B. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Powell Valves.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

2.06 DUCTILE IRON LUG TYPE BUTTERFLY VALVE

- A. EPDM Seals and Seats
- B. Gear Operator
 1. Pre-installed operator and handwheel
- C. Aluminum Bronze Disc
- D. Epoxy coated lug body
 1. Tapped lugs and supported seat
- E. Extended neck to clear piping insulation
- F. Bi directional flow
- G. Minimum Cold Working Pressure (CWP): 200 psi
- H. Working Steam Pressure (WSP): 125 psi

2.07 CHAINWHEELS

- A. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or

Government approved equivalent:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to ball and butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.
- F. Where threaded bronze valves are used for copper pipe exercise care to avoid deforming the pipe (or valve) with wrench application.

3.02 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for ball, butterfly, and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor or lower.

3.03 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. It is the intent and part of the project scope that a valve be provided for isolation of steam meters from the live steam supply and that chilled water meters be provided with isolation valves on the supply and system sides of those meters to isolate the meters from the chilled water system on both sides of the meter.
 - 1. The valves shall be placed upstream of steam and chilled water meters just before the meter manufacturer's recommended upstream straight pipe length.
 - 2. An isolation valve shall be placed downstream of chilled water meters just after the meter manufacturer's recommended downstream straight pipe length.
 - 3. Where valves are existing and proven to hold during the construction, additional valves shall not be required to be added.
- B. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly, or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
- C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- D. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
 - 4. For Steel Piping, NPS 2 and Smaller: Threaded or Flanged ends.
 - 5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - 6. For Steel Piping, NPS 5 and Larger: Flanged ends.
 - 7. For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.05 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Ball Valves: Two-piece, full port, bronze with stainless-steel trim.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
 - 2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 and larger: 200 CWP, EPDM seat,

aluminum-bronze disc.

3.06 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:

1. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Gate Valves: Class 250, OS&Y.

3.07 HIGH- AND MEDIUM-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:

1. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Gate Valves: Class 250, OS&Y.

3.08 STEAM-CONDENSATE VALVE SCHEDULE

A. Bronze Gate Valves: Class 150, NRS.

END OF SECTION

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SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Copper-Plated Steel Swivel Loop Hangers for copper tubing.
 - 5. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 6. Clevis Hangers for Insulated Piping
 - a. Designed to fit the OD (Outside Diameter) of the pipe insulation.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Floor Mounted Pipe Supports:
 - 1. Stanchion type adjustable pipe saddle support with yoke meeting Federal Specifications A-A-1192A (Type 38) and WW-H-171E (Type 39), and MSS SP-69 (Type 38) on a single length of threaded schedule 40 pipe attached to a malleable iron flange base.
 - 2. The size of the threaded schedule 40 pipe used for pipe stands shall be no less than:
 - 3. 1-1/2" for pipe 2-1/2" and smaller
 - 4. 2" for 3" pipe
 - 5. 4" for 4" pipe and larger.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- C. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- D. Install lateral bracing with pipe hangers and supports to prevent swaying.
- E. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- H. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

- b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 3. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for hangers and supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and 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. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.03 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.04 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings (including copper plated steel) on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- F. Floor Mounted Pipe Support:

1. Pipe diameters up to and including 10 inch Schedule 40 are permitted to be supported by 2 in. diameter pipe stands when all the following conditions are met:
 - a. The maximum height shall be 3 feet, as measured from the base of the pipe stand to the centerline of the pipe being supported.
 - b. The pipe stand shall be axially loaded only.
2. For floor support applications higher than 3 feet, and only with the approval of DGS, pour square reinforced, concrete pillars that are at least 8 inches wider than the outside dimension of the pipe to be supported and set pipe stands complying with the above atop the pillars. Comply with requirements for concrete housekeeping pads and pipe/valve support pillars in Section 230000.

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Pipe labels.
 - 3. Valve tags.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- C. Valve numbering scheme.
- D. Valve Schedules: For each piping system to include in maintenance manuals.

1.04 COORDINATION

- 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.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 3. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances 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. Fasteners: Stainless-steel rivets.
 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, 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 using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches high.

2.03 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material:
 - a. Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - b. Aluminum
 - c. Plastic (not permitted for steam)
 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
 3. Size: Credit Card Size (3.375 inches wide by 2.125 inches high) or larger.
- B. Engraved Valve Tags, Custom Stamped Labels, Laser Engraved Plastic, Aluminum or Brass Tags, Chilled Water and Steam Shut off Tags.

- C. Data:
 - 1. Valve Service
 - 2. Valve/Pipe Size
- D. 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. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Clean piping insulation and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. Labels for meters shall match tags on the Drawings

3.03 PIPE LABEL INSTALLATION

- A. 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. Near each valve and control device.
 - 2. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 3. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 4. On both sides of new meters installed in piping systems
- B. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. High / Medium / Low Pressure Steam and Steam Condensate Piping:
 - a. Background Color: Yellow

- 3. Letter Color: Black
- 4. Gas Piping:
 - a. Background Color: Yellow

3.04 VALVE-TAG INSTALLATION

- A. Install tags on valves, flow meters in piping systems, and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Credit Card size or larger
 - b. Rectangular
 - 2. Valve-Tag Color:
 - a. Chilled Water: Green.
 - b. Steam: Metallic Yellow.
 - c. High / Medium / Low Pressure Steam Condensate: Natural.
 - 3. Letter Color:
 - a. Chilled Water: White
 - b. High / Medium / Low Pressure Steam and Steam Condensate: Black.

END OF SECTION

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section includes insulating the following HVAC piping systems:

1. Chilled-water and brine piping, indoors .
2. Steam and steam condensate piping, indoors .

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.04 QUALITY CONTROL

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.06 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.07 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General" and "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. All covering and insulating materials used on this project must contain the manufacturer's name on the containers. All materials must be dry and in good condition, free of defects, mildew, rough ends, etc.
- G. Manufacturers: Insulation materials shall be:
 - 1. Certainteed,
 - 2. Owens-Corning,
 - 3. Johns Manville,
 - 4. Lewco,
 - 5. Armstrong,
 - 6. Knauf

7. or equal subject to the approval of DGS.

2.02 PREFORMED-PIPE-TYPE, MINERAL-FIBER THERMAL-INSULATION

- A. ASTM C 547
- B. Types I: suitable for operating temperatures up to 850 degrees F molded.
- C. Type II: suitable for operating temperatures up to 1,200 degrees F molded.
- D. Type III: suitable for operating temperatures up to 1,200 degrees F V-groove.
- E. Thermal conductivity: 0.25 Btu-in/hr. sq. ft. F.
- F. Grade A.
- G. Facing:
 - 1. All Service Jacket (ASJ): White, kraft-paper, reinforced fiberglass scrim with aluminum foil back.

2.03 FIBERGLASS PIPE INSULATION WITH ALL SERVICE JACKET (ASJ)

- A. Operating Temperature Range: 0°F to 850°F
 - 1. ASTM C411
- B. Thermal Conductivity (k Btu*in/hr*ft²*°F)
 - 1. .029-.032 at Mean Temperature of 200°F for steam and steam condensate.
 - 2. 0.21-0.27 for chilled water.
- C. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 1. Cleanable, wrinkle-resistant, resists water staining, and doesn't support mold or mildew growth.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. All jacket shall be painted using ANSI A13.1 color coding per piping service type.

2.04 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

2.05 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 200 deg F.
 - 3. Solids Content: 63 percent by volume and 73 percent by weight.
 - 4. Color: White.

2.06 TAPES

- A. ASJ Tape: Vapor-retarder tape with acrylic adhesive, complying with ASTM C 1136.
 - 1. 3 inches wide and 11.5 mils.thick.
 - 2. Adhesion: 90 ounces force/inch in width.
 - 3. 2 percent elongation and 40 lbf/inch tensile strength.

2.07 SECUREMENTS

- A. Bands:
 - 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inchwide with wing or closed seal.
 - 2. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Wire: 0.080-inch nickel-copper alloy.

2.08 REMOVABLE INSULATION JACKETS

- A. Quality Assurance
 - 1. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum Five years of documented experience with audited quality standards certified ISO 9001:2015 or greater.
 - 2. Performance: maximum touch temperature of 120°F under operating conditions.
- B. Preformed Thermal Jackets (Maximum Temperature 475°F) for Steam and Steam Condensate
 - 1. Material layers shall be manufacturer's standard non-asbestos or:
 - a. Jacket: Hot Side: Silicone or PTFE Fiberglass Composite, 16.5 oz/square yard, rated to 550°F
 - b. Thread: Kevlar, 35lb breakpoint, rated to 800°F. Thread must be able to withstand the skin temperatures without degradation.
 - c. Insulation Layer 1: 1" Needled fiberglass, 5 lb/cu ft, rated to 1100°F
 - d. Insulation Layer 2: 0.25 Ceramic Paper. Pyrogel
 - e. Jacket - Cold Side: Silicone or PTFE Fiberglass Composite, 16.5 oz/square yard, rated to 550°F
 - f. Fasteners: Nylon or PTFE Straps
 - g. Seal Flaps: Material rated to 600°F with Kevlar cord (rated to 900°F).
- C. Construction:

1. Sewn with lock stitch at a minimum of 4 to 6 stitches per inch.
2. No raw cut jacket edges shall be exposed after install.
3. Jackets shall be fastened using a combination of hook and loop, straps, and D-rings.
4. Insulation shall be designed to minimize the convection current in the space between the hot metal surface and the inner layer of insulation.
5. All jacket pieces matching mating seams shall include an extended 2" flap constructed from the exterior fabric (or equivalent) and shall be secured using hook & loop closure parallel to the seam or straps and/or D-Rings depending on application temperature.
6. Insulation shall be sewn as integral part of the jacket to prevent shifting of the insulation.
 - a. Insulation pins are NOT an allowable method of preventing the insulation from shifting and shall NOT be used.
7. Construct steam trap jackets in a box shape for ease of removal and replacement for inspection and maintenance.

2.09 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C1136, Type I, unless otherwise indicated.
- B. FSK Jacket: (Foil Scrim Kraft) Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing. Flame-retardant, vapor-barrier.
- C. ASJ Jacket: (All Service Jacket) Light-weight aluminum foil layered with a tri-directional fiberglass reinforcing scrim and then attached with high-intensity White Kraft paper. Flame-retardant, vapor-barrier.

PART 3 - EXECUTION

3.01 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.
 3. Verify the space around the pipes in this existing building will accept the insulation as scheduled.
 - a. Measure and document the thickness of the existing insulation on all pipe where insulation will be removed and subsequently replaced after pipe work is completed.
 4. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. 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.

3.03 GENERAL INSTALLATION REQUIREMENTS

- A. 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.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. 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.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered. Layers of insulation shall include a vapor barrier only on the final (outside layer) of insulation.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with 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 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.
 5. All chilled water pipe shall have a continuous vapor barrier. Where the factory installed vapor barrier on insulation is compromised or damaged, reestablish with a field applied jacket.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 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. Install insulation with longitudinal seams at bottom of pipe. 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.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. The final insulation shall be clean and workmanlike in appearance with smooth jacket and not irregularities. It shall be suitable to accept self-adhesive pipe identification labels so that the labels make full contact with the insulation and adhere permanently thereto.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. 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.
- Q. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.04 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Provide Removable Insulation Jackets for Steam and Steam Condensate on:

1. The Flanged or Inline Assembly for the Primary Element of New DP Meters
2. Valves
3. Strainers
4. Steam Traps
5. Pressure Reducing Valves
6. Control and Balancing Valves

C. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive. Insulate the inline housing of the electromagnetic chilled water meters as with tee fittings and include seams so that insulation can be readily disassembled in the event of required maintenance, service, or replacement.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, 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.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

D. 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.

- E. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below or any "Interior Painting" specifications section.
 - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: White. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

3.06 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation shall wherever possible meet the current thickness prescribed in the International Energy Conservation Code Table C403.11.3.
 - 1. In this existing building space constraints may require deviation from the insulation schedule prescribed for steam and steam condensate. It is not the intent to move adjacent major piping systems or other building services to meet the current requirements for insulation thickness. Make adjustments to insulation thickness to suit the existing conditions--allowing for installation, reasonable clearance, access to equipment and swing of doors. Where space constraints require deviation from the scheduled insulation thickness, the insulation applied shall be no less than the thickness of the existing insulation. The contractor shall survey pipe where the space will be at a

premium, document the existing thickness of pipe insulation and inform DGS of the anticipated space constraint for evaluation and consensus before demolition.

- B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.07 INDOOR PIPING INSULATION SCHEDULE

- A. Chilled Water, above 40 Deg F:

1. NPS 12 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches thick.
2. NPS 14 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber Preformed Pipe, Type I: 4" thick.
3. Re-establish vapor barrier and apply mastics, sealant and tape to ensure continuity of vapor barrier between new and existing insulation.

- B. Steam and Steam Condensate, 350 Deg F and Below:

1. NPS 3/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.
2. NPS 1 and 1-1/4: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II: 4 inches thick.
 - b. Mineral-Fiber, Preformed Pipe, Type I or II: 4.5 inches thick.

3.08 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material where the insulation does not come with a factory applied ASJ. *Possible variations of jackets by location are endless. This article specifies locations in two broad categories: concealed and exposed. Revise if additional delineation is necessary.*

END OF SECTION

SECTION 230800 - HVAC SYSTEMS COMMISSIONING

PART 1 – GENERAL

1.01 STIPULATIONS

- A. The Specifications Sections "General Conditions of Contract", "Special Conditions" and "Division 1 – General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Section 019100 - Commissioning Requirements.
- C. All Division 23 Specification Sections apply to this Section.

1.03 SYSTEMS TO BE COMMISSIONED

- A. The systems that shall be commissioned in this project include but are not limited to the following:
 - 1. Utility Metering Systems including Chilled Water & Steam.
 - 2. Building Automation System integration of all metering systems.

1.03 SCHEDULING

- A. The CxA will provide the initial schedule of primary commissioning events using the information gathered from the commissioning scoping meeting. The Commissioning Plan provides a format for this schedule. The timeline is fine-tuned as construction progresses. In particular, 30 days prior to startup of the primary HVAC equipment, the CxA meets with the DGS, UA and Contractors and develops a detailed commissioning schedule. The CxA will approve the commissioning schedule.
 - 1. Lead Contractor shall coordinate requirements of Construction Scheduling with this work.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- A. The .2 Contractor shall provide all standard testing equipment required to perform startup, initial checkout, and testing requirements of Division 23.
- B. The 0.2 Contractor or the Controls Subcontractor shall provide all standard testing equipment required to test the control system and the packaged controls, including calibration of meters.

Trend logs for functional testing shall be generated through the control system, as requested by the CxA.

- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the following tolerances. Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.01 RESPONSIBILITIES

- A. 0.2 Contractor and Controls Subcontractor. The commissioning responsibilities applicable to each of the 0.2 Contractor and Controls Subcontractor of Division 23 are as follows:

Construction and Acceptance Phases

1. Attend the initial commissioning meeting conducted at the start of construction, the commissioning meeting held 30 days prior to startup of the primary equipment, and all commissioning team meetings.
2. Copies of approved shop drawings and startup reports for all commissioned equipment shall be submitted to the CxA through E-Builder. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.
3. The Operation and Maintenance Manuals shall be submitted to the CxA, through E-Builder prior to the start of training (3 weeks before start-up and training and at least 60 days before substantial completion). Manuals shall include recommended operating procedures.
4. During the startup and initial checkout process, execute all portions of the manufacturer's start-up checklists and prefunctional checklists for all commissioned HVAC equipment. Refer to Section 01900.
5. Perform and clearly document all completed startup and system operational checkout procedures and prefunctional checklist providing copies to the CxA. Refer to Section 01900
6. Address current Professional punch list items and Commissioning corrective action items before functional testing.
7. Provide skilled technicians to execute starting of equipment and to perform tests in accordance with all Division 23 sections. Where specified, startup shall be performed by a factory authorized service representative. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
8. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and Professional and retest the equipment.
9. Provide training of Using Agency's operating staff as specified in Division 23 Sections. Use expert qualified personnel.
10. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

Warranty Period

11. Correct deficiencies and make necessary adjustments to O&M manuals for applicable issues identified in any seasonal testing.
- B. 0.2 Contractor. The responsibilities of the 0.2 Contractor, during construction and acceptance phases in addition to those listed in (A) are:
1. Provide startup for all HVAC equipment.
 2. Supervise all commissioning activities executed by subcontractors, including the Controls Subcontractor.
 3. List and clearly identify on the as-built piping drawings the locations of all flow meters and temperature sensors.
- C. Controls Subcontractor. The commissioning responsibilities of the Controls Subcontractor, during construction and acceptance phases in addition to those listed in (A) are:
1. Sequences of Operation Submittals. The Controls Subcontractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 - b. Logic diagrams detailing the flow of information for each control algorithm. These diagrams should include all inputs, outputs, and computations.
 - c. All interactions and interlocks with other systems.
 - d. Detailed delineation of control between any packaged controls, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - e. Effects of power or equipment failure with all standby component functions.
 - f. Sequences for all alarms.
 - g. To facilitate referencing in testing procedures, all sequences shall be written in small statements, each with a number for reference.
 2. Control Drawings Submittal:
 - a. The control drawings shall have a key to all abbreviations.
 - b. The control drawings shall contain graphic schematic depictions of the systems and each component.
 - c. The schematics shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - d. Provide a full points list with at least the following included for each point:
 - 1) Controlled system
 - 2) Point abbreviation
 - 3) Point description
 - 4) Display unit
 - 5) Control point or setpoint (Yes / No)
 - 6) Input point (Yes / No)
 - 7) Output point (Yes / No)
 - e. The Controls Subcontractor shall keep the Professional, CxA and 0.2 Contractor informed of all changes to this list during programming and setup.
 3. Submit a written checkout plan indicating in a step-by-step manner, the procedures that will be followed to test, checkout and adjust the control system prior to functional testing. At minimum, the checkout plan shall include for each type of equipment controlled by the building automation system:
 - a. System name.
 - b. List of devices.

- c. Step-by-step procedures for testing each controller after installation, including:
 - 1) Process of verifying proper hardware and wiring installation.
 - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - 3) Process for performing and documenting point-to-point checkout for each digital and analog input and output.
 - 4) Process of performing operational checks of each controlled component.
 - 5) Plan and process for calibrating all sensors.
 - 6) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
- d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor, controller or command has "passed" and is operating within the contract parameters.
- e. A description of the instrumentation required for testing.
- 4. Point-to-Point Checkout: Include in the checkout plan a point-to-point checkout. Each control point tied to a central control system shall be verified to be commanding, reporting and controlling according to its intended purpose.
- 5. Calibrations: The CONTROLS SUBCONTRACTOR is responsible to calibrate all field installed meters using test and documentation methods approved by the Professional.
 - a. All procedures used shall be fully documented by the Controls Subcontractor on suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
- 6. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as indicated in the Specifications.

3.02 SUBMITTALS

- A. Copies of MEP shop drawings will be provided to CxA, when they are submitted to the Professional, electronically through E-Builder. CxA will review shop drawings concurrently with the Professional and provide any comments to the Professional so they may be included in their comments. Copies of approved shop drawings and startup reports for all commissioned equipment will be forwarded to the CxA through E-Builder. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.
- B. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Professional will approve them.

3.03 STARTUP

- A. The 0.2 and Controls Contractors shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section. Equipment start-up is required to complete systems and sub-systems so they are fully functional, in compliance with the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the Commissioning Agent or Department.
- B. Testing is intended to begin upon completion of a system. Refer to Section 019100 for additional information related to scheduling.

3.04 TESTS

- A. The 0.2 Contractor and Controls Subcontractor shall provide the necessary support to the CxA to complete functional testing. The Controls Subcontractor shall fully test and verify all aspects of the BAS Contract Work on a point / system / integrated operational basis for all points, features and functions specified. The following requirements apply to all mechanical and control systems and features that are to be commissioned when referenced below. Tests shall:
1. Verify functionality and compliance with the basis of design for each individual sequence module in the sequence of operations. Verify proper operation of all control strategies, energy efficiency and self-diagnostics features by stepping through each sequence and documenting equipment and system performance.
 2. Verify operation of systems and components that may be impacted during low, normal and high load conditions and during combinations of environmental and interacting equipment conditions that could reasonably exist and potentially result in adverse system reaction.
 3. Verify all alarm and high and low limit functions and messages generated on all points with alarm settings.
 4. Verify integrated performance of all components and control system components, including all interlocks and interactions with other equipment and systems.
 5. Verify that all control system graphics are representative of the systems and that all points and control elements are in the same location on the graphic as they are in the field.
 6. Verify operator control of all adjustable control system points including proper access level as agreed to during the controls system demonstration.
- B. In addition to specific details, and/or standards referenced for acceptance testing indicated in other Division 23 sections, the following common acceptance criteria apply to all mechanical equipment, assemblies and features:
1. For the conditions, sequences and modes tested, the equipment, integral components and related equipment shall respond to varying loads and changing conditions and parameters appropriately as expected, according to the sequence of operation, as specified, according to acceptable operating practice and the manufacturer's performance specifications.
 2. Systems shall accomplish their intended function and performance at specified levels at varying conditions.
 3. Control loops shall be stable under all operating conditions. Control loops shall exhibit a quarter decay ratio type response to a step change or other upset and return to stable operation in a time frame that is reasonable and realistic for the system that they are associated with.
- C. At the CxA's discretion, if large numbers or repeated deficiencies are encountered, the CxA shall suspend functional testing until the Contractor corrects the deficiencies and troubleshoots all remaining systems at issue on their own. The Contractor shall be responsible for any resulting schedule delays that increase the overall time period to complete functional testing.

3.05 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors shall consist of the filled out start-up, initial checkout, prefunctional checklists and test documentation in accordance with all Division 23 sections.

END OF SECTION 230800

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SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections General Conditions to the Construction Contract• , Special Conditions• and Division 01 - General Requirements• form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
 - 2. Section 230993 "Sequence of Operations for HVAC Controls" for requirements that relate to this Section.

1.04 DEFINITIONS

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. MS/TP: Master slave/token passing.
- D. PID: Proportional plus integral plus derivative.
- E. RTD: Resistance temperature detector.

1.05 SYSTEM PERFORMANCE

- A. The contractor shall provide wiring and hardware; make connections; and program the building's existing system with points to monitor the temperature, pressure and flow, and calculate energy usage or heat transfer as applicable, with trending and totalization of the fluids to be measured and monitored by the newly installed meters.
 - 1. The contractor shall develop a screen presentation in close coordination with the Department of General Services' Energy & Resource Management Office that is initially

acceptable to the facilities management staff with the capability for addition of data capture, trending and manipulation for future energy and resource savings initiatives.

1.06 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
 - 4. Controlled Systems:
 - a. Schematic diagrams of each system with monitor points labeled and metering/sensor elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of points monitoring and intended graphical output including schematic diagram.
 - d. Points list.
- B. Operation and Maintenance Data: For Plumbing and HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Maintenance instructions and lists of spare parts for each type of control device.
 - 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 - 3. Calibration records and list of set points.

1.07 QUALITY CONTROL

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project. The controls vendors are proprietary and are limited to:
 - 1. Automated Logic
 - 2. Johnson Controls
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE 135 for DDC system components.
- D. The proprietary controls vendors are also the current controls contractors for the subject buildings. Using their intimate knowledge of the buildings and their continuing and

long-standing relationship with the facilities management, the vendors shall coordinate with the client agency to develop a graphical user interface to display data in a manner acceptable to the facilities' controls manager.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.09 COORDINATION

- A. Coordinate location of temperature and pressure sensors, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Section 260913 "Electrical Power Monitoring" to achieve compatibility of communication interfaces.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. The controls manufacturer/vendor shall be proprietary so as to effect a seamless integration of all the project components. Controls shall be from:
 - 1. Automated Logic (ALC) and by the facilities controls maintenance contractor. Contact Randy Robertson at (717) 798-4066, randy.robertson@carrier.com to provide the controls for those buildings in this project where ALC is the control system installed in the building.
 - 2. Johnson Controls (JCI) and by the facilities controls maintenance contractor. Contact Christopher Barlow at 717-418-3878 or 717-712-1871, christopher.j.barlow@jci.com to provide the controls for those buildings in this project where JCI is the control system installed in the building.
- C. The above items have been approved by the Department as a Proprietary Item. No other items will be accepted. Article 9, Paragraph 9.6, Substitution of Materials, of the General Conditions to the Construction Contract does not apply to the above items.

2.02 CONTROL SYSTEM

- A. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

- B. BACNET protocol preferred. If MODBUS is standard for meters provide MODBUS to BACNET Converter Card.
- C. Provide hardware compatible with the existing control system installed on the premises. The control system components shall be JCI and ALC.
- D. Controllers
 - 1. Johnson Controls:M4-CGM/XPM Series Standard Control Panel Assembly and Input/Output Expansion Module (XPM)
 - a. Pre-wired, preassembled standard control panel that contains a CGM controller and if needed an XPM Input/Output Expansion Module.
 - b. Delivered complete and mounted in a NEMA 2 or NEMA 3R steel enclosure.
 - 1) Enclosure minimum dimensions: 24 in. x 20 in. x 8 in.
 - 2) Enclosure finish ANSI 61 manufacturer's standard color or gray polyester powder coating.
 - c. Power supply incorporating a convenience outlet, circuit breaker, and a 120/24 VAC transformer as appropriate to power the controllers and the meters. Single Power Supply, 120 Vac to 24 Vac, UL Class 2, Metal Enclosure
 - d. Wire size
 - 1) Ground wire: 14 AWG
 - 2) Transformer wires: 16 AWG
 - e. Color-coded and clearly labeled screw terminals for easily identifiable input/output.
 - f. Ambient operating conditions: 32°F to 122°F
 - g. Ten-point 24 V distribution terminal block.
 - h. Provide separate transformer to power meters.
 - i. Include a CGM04060 or CGM09090 controller, which communicates using BACnet®MS/TP or wireless Zigbee®networks and integrates with Johnson Controls®and third-party systems as appropriate.
 - j. UL 508A-rated control panel, UL 50 enclosure.
 - 2. Automated Logic:
 - a. Pre-wired, preassembled standard control panel that contains a controller and if needed an expansion module.
 - b. Delivered complete and mounted in a NEMA 2 or NEMA 3R steel enclosure.
 - 1) Enclosure minimum dimensions: 24 in. x 20 in. x 8 in.
 - 2) Enclosure finish manufacturer's standard color powder coating.
 - c. Power supply incorporating a convenience outlet, circuit breaker, a 96 VA 120/24 VAC transformer, and two 120 VAC outlets.
 - d. Wire size
 - 1) Ground wire: 14 AWG
 - 2) Transformer wires: 16 AWG
 - e. Color-coded and clearly labeled screw terminals for easily identifiable input/output.
 - f. Ambient operating conditions: 32°F to 122°F
 - g. Provide separate transformer to power meters.

- h. 24 V distribution terminal block.
- i. Include a controller that integrates with ALC and new meter to accomplish the required performance as specified and as further coordinated with the facilities' controls management manager.
- j. UL 508A-rated control panel, UL 50 enclosure.
- k. Existing System Controllers Include:
 - 1) SE 6166 Control Module: 16 universal inputs. High-speed, native BACnet over ARC156 communications. BACnet over MS/TP communication is also supported.
 - 2) ZN253 Zone Controller: 5 universal inputs. High-speed, native BACnet over ARC156 communications. Supports native BACnet over MS/TP communications when required. Allows complete independence from any other devices in the system. Firmware upgrades can be performed remotely. Battery-backed real time-clock keeps time in the event of power failure or network interruption.
- l. New controllers shall be compatible with the existing system.
 - 1) It is not the intent of this project to upgrade the entire BMS for each building nor for the campus network.
 - 2) The intent of the project and the performance objective is to capture the data from new meters and display it in a manner acceptable to the controls systems operators. The data capture, storage and retrieval scheme shall also include flexibility so as to make feasible future additional programming to analyze energy and water usage for initiatives in sustainable resource and energy conservation.

2.03 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or pipe mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Accuracy: Plus or minus 0.36 deg F at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Temperature and pressure sensors: Watertight inlet fitting.
- C. RTDs and Transmitters:
 - 1. Accuracy: Plus or minus 0.2 percent at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
- D. Immersion Temperature Sensors:
 - 1. Probes
 - a. 2", 4" or 8" length (selected based on pipe size).
 - b. Thermally conductive epoxy filled.
 - c. Etched Teflon leadwires.
 - d. Watertight.
 - 2. Manufacturer's standard thermowell selected to match probe.

3. 304 Stainless Steel or manufacturer's standard equivalent.
4. Set in a standard steel junction box.
5. Make allowance for pipe insulation.
6. Operation range: select to match service where used.

2.04 SUPPORT APPURTENANCES

- A. 12- and 14-ga. punched strut channels.
 1. 1-1/2" center-to-center spacing
- B. Strut channel: 1-5/8" x 1-5/8"
- C. All channel members shall be fabricated conforming to one of the following ASTM specifications:
 1. Plain Carbon Steel: A 1011 SS Grade 33
 2. Stainless Steel: A 240 (Type 304)
- D. Finishes
 1. Carbon steel shall be factory painted with rust inhibiting enamel paint applied after cleaning and prepping, and thoroughly baked.
- E. Accessories: Steel channel Spring Nuts, Channel Bolts
 1. Electro Galvanized Finish,

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that conditioned power supply is available to control units and operator workstation. In the absence of such power, the contractor shall provide wiring, breaker and as required transformers to furnish the required power.

3.02 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of control sensors with Drawings and room details before installation
- D. Install panels and cabinets offset from walls using strut system.
 1. Set Strut System components into final position true to line, level and plumb.
 2. Anchor material firmly in place and tighten all connections to their recommended torques.

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems." Control wiring raceway shall be factory painted blue.
- B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Provide transformed power to steam, water, chilled water and domestic water and gas meters. Obtain manufacturer's product data sheets and provide power as appropriate.
- D. Power all controllers.
- E. Where electrical drawings explicitly show power to panels, the mechanical contractor is not obligated to provide a redundant power circuit.
- F. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
 - 1. Conceal wiring in walls and above ceilings, except in mechanical rooms and areas where other conduit and piping are exposed.
 - 2. Install all cable in raceway. Exposed cable and wiring shall not be installed.
 - 3. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 4. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - 5. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

3.04 CONNECTION TO METERS

- A. Make connections through control wiring/cabling in blue control EMT.
- B. Calibrate 4-20 signal to be received, processed, and displayed accurately and matching the transmitter output of each meter.
- C. Interface with and capture data from:
 - 1. Electric Meters (See Electrical Drawings)
 - 2. Gas Meters (See Plumbing Drawings)
 - 3. Domestic Water Meters (See Plumbing Drawings)
 - 4. Chilled Water Meters
 - 5. Steam Meters
- D. Display shall at the least indicate current flow of fluid and energy in:
 - 1. Gallons per minute (gpm) for water and chilled water.
 - 2. Pounds per hour for steam.
 - 3. Standard cubic feet per minute for natural gas.
 - 4. Totalization based on period of flow selectable by a user of the controls system.
 - 5. Fluid temperature.
 - 6. Fluid pressure.
 - 7. Energy usage or heat transfer in tons or BTU of cooling, BTU of heat, therms or SCFM of natural gas, kW of electrical energy used.

8. Standard controls vendor options for trending and graphical display of data using line, bar, pie and x-y charts shall be provided via programming in coordination with the facilities controls manager.

3.05 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each system for compliance with sequence of operation.
 6. Test software and hardware interlocks.
- C. DDC Verification:
 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check temperature instruments and material and length of sensing elements.
 5. Check DDC system as follows:
 - a. Verify that DDC controller power supply is functional.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.06 ADJUSTING

- A. Calibrating and Adjusting:
 1. Calibrate instruments.
 2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 4. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span

using a precision-resistance source.

5. Provide diagnostic and test instruments for calibration and adjustment of system.
6. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

D. Add new sensors and meters to screenshots that display all controls devices on the building management systems. Where devices are removed from the system, they shall also be deleted from the relevant screenshots. Errors indicating absent devices that have been removed and unidentified new devices shall not appear on the controls system.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 230900

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
 - 1. Chilled-water piping.
 - 2. Makeup-water piping.

1.03 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
 - 1. Chilled-Water Piping: 125 psig at 200 deg F.
 - 2. Makeup-Water Piping: 80 psig at 150 deg F.

1.04 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.05 QUALITY CONTROL

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. 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 VIII, Division 1.

PART 2 - PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L .
- B. Wrought-Copper Fittings: ASME B16.22.
 - 1. Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or Government approved equivalent:
 - a. Anvil International, Inc.
 - b. S. P. Fittings; a division of Star Pipe Products.
 - c. Victaulic Company.
- C. Wrought-Copper Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- C. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.
- D. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- E. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- F. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.03 SPECIALTIES

- A. 3/4" Quarter Turn Boiler Drain (Drain Cock)
 - 1. Quarter-turn ball valve design
 - 2. Positive shutoff
 - 3. Brass body
 - 4. 3/4 in. hose thread connection
 - 5. Tee-handle design
 - 6. Adjustable stem packing

- B. Automatic Air Vent
 - 1. Connection Type: Threaded
 - 2. Max Pressure (PSI): 150
 - 3. Material: Brass or Bronze
 - 4. Internals: Non-Ferrous
 - 5. Thread Type: Male
 - 6. Body Pattern: Straight
 - 7. System Type: Hydronic (Water)

2.04 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- B. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
 - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3.02 CLEANING AND FLUSHING

- A. Clean all pipe thoroughly after demolition (cutting pipe) and before construction and meter installation. Flush the new pipe. Inspect all strainers daily after putting system on line. Strainers shall be monitored daily, and cleaned until two clean strainer episodes occur, then monitored and cleaned weekly until two clean strainer episodes occur before turnover to client.

3.03 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems indicate general piping locations and arrangements. Install piping as indicated unless deviations to layout are proposed on Contractor Shop Drawings and approved by DGS.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal where applicable.
- E. Install piping to permit valve servicing.
- F. Install piping level unless slope is explicitly indicated.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation. Install specialties on nipples and valves with stem extensions (as applicable) to clear insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- M. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- N. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- O. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Identify piping as specified in Section 230553 "Identification for HVAC Piping and Equipment."
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.04 HANGERS AND SUPPORTS

- A. Hanger, support, and anchor devices are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 - 6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 - 8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 - 10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
 - 11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
 - 12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
 - 13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
 - 14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
 - 15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. 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 unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 HYDRONIC SPECIALTIES INSTALLATION

- A. Provide a tapped weld-on boss for hydronic specialties attachment to steel pipe. Provide a pipe nipple to offset specialties 6 inches above insulation on primary pipe—insulate the nipple and close the vapor barrier with mastic.
- B. Air vents:
1. Install a manual air vent and an automatic air vents just outside of meter manufacturers' required straight pipe lengths upstream and downstream of meters just before the valves that isolate the meter.
 2. The manual air vent shall be ¾-inch and be installed at the top of pipe, as required to allow for rapid system air venting inside the pipe that is isolatable with the valves on each side of chilled water meters. The automatic air vent shall be equipped with an isolation ball valve and shall be installed at the highest point in the subject part of the chilled water pipe system.
- C. Drain: Provide a boiler drain fitting at the bottom of the chilled water that is isolatable using the valves that isolate the chilled water meter. The location of the drain cock shall be outside the required straight pipe length but before the isolation valve for the meter so as to drain down the subject pipe for maintenance, repair or replacement of the meter.

3.07 FIELD QUALITY CONTROL

- A. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
 5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.

B. Perform the following before operating the system:

1. Open manual valves fully.
2. Fill Pipe: Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
3. Set temperature controls so all coils are calling for full flow.

END OF SECTION

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SECTION 232213 - STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. This Section includes the following for steam and condensate piping:
 - 1. Pipe and fittings.

1.03 DEFINITIONS:

- A. Low Pressure (LP) Steam: Steam at pressure less than or equal to 15 psig.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent corrosion and entrance of foreign matter.
- B. Deliver and store valves in shipping containers with labeling in place.

1.05 QUALITY CONTROL

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
- B. Welding Materials and Procedures: Conform to ANSI/ASME SEC 9.
- C. Pipe Welding: Qualify processes and operators according to the following:
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current and remains current for the duration of the project.
- D. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- E. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 STEEL PIPE AND FITTINGS

- A. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300 as indicated in Part 3 piping applications articles.
- B. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 piping applications articles.
- C. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
- D. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
- E. 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 deg F.

2.02 STEEL PIPING (0 TO 125 PSIG)

- A. Steel Pipe; 0 to 125psig; Standard Weight; Threaded Joints:
 - 1. Design Pressure: 125 psig. Maximum Design Temperature: 353°F.
 - 2. Pipe: Standard weight black steel, threaded and coupled, ASTM A53.
 - 3. Joints: Screwed.
 - 4. Fittings: 125 psi S- 175 psi. WOG, cast iron, ASTM A126, ANSI B16.4.
 - 5. Unions: 250 psi S- 500 psi. WOG, black malleable iron, ground joint with brass seat.
- B. Steel Pipe; 0 to 125psig; Standard Weight; Flanged Joints or Welded Joints:
 - 1. Design Pressure: 125 psig. Maximum Design Temperature: 353°F.
 - 2. Pipe: Standard weight black steel, beveled ends, ASTM A53.
 - 3. Joints: Butt welded or flanged.
 - 4. Fittings: Standard weight seamless steel, butt welded type, ASTM A234, Grade WPB, ANSI B16.9.
 - 5. Flanges: 150 lb. forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.
- C. Steel Pipe; 0 to 125psig; Extra Strong; Threaded Joints:
 - 1. Design Pressure: 125 psig. Maximum Design Temperature: 353°F.
 - 2. Pipe: Extra strong black steel, threaded and coupled, ASTM A53.
 - 3. Joints: Screwed.
 - 4. Fittings: 125 psi S- 175 psiWOG, cast iron, ASTM A126, ANSI B16.4.
 - 5. Unions: 250 psi- 500 psiWOG, black malleable iron, ground joint with brass seat.

2.03 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

PART 3 - EXECUTION

3.01 LP STEAM PIPING APPLICATIONS

- A. NPS 2 and smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. NPS 2-1/2 and larger: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Condensate piping shall be the following:
 - 1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.02 MP and HP STEAM PIPING APPLICATIONS

- A. NPS 2 and smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. NPS 2-1/2 and larger: Schedule 40, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.
- C. Condensate piping shall be the following:
 - 1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.

3.03 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping

systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
- M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated.
- S. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
 - 1. On straight runs with no natural drainage points, install drip legs at intervals not

- exceeding 300 feet.
 - 2. Size drip legs same size as main. In steam mains NPS 6 and larger, drip leg size can be reduced, but to no less than NPS 4.
 - T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
 - U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
 - V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."
- 3.04 HANGERS AND SUPPORTS
- A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.
 - B. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - C. Install hangers with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
 - 6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
 - 7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 - 8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
 - 9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
 - 10. NPS 10: Maximum span, 26 feet; minimum rod size, 3/4 inch.
 - 11. NPS 12: Maximum span, 30 feet; minimum rod size, 7/8 inch.
 - 12. NPS 14: Maximum span, 32 feet; minimum rod size, 1 inch.
 - 13. NPS 16: Maximum span, 35 feet; minimum rod size, 1 inch.
 - 14. NPS 18: Maximum span, 37 feet; minimum rod size, 1-1/4 inches.
 - 15. NPS 20: Maximum span, 39 feet; minimum rod size, 1-1/4 inches.
 - D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1/2: Maximum span, 4 feet; minimum rod size, 1/4 inch.
 - 2. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

E. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.05 PIPE JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. 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 unless dry seal threading is specified.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Welded Joints: Construct joints according to AWS D10.12 (), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.06 CLEANING PIPING

- A. Assembly:
 1. After demolition (cutting existing pipe) but prior to assembly of new pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice subject to the approval of the Construction Manager. Chips and burrs from machinery or thread cutting operation shall be blown out of pipe before assembly. Cutting oil shall be wiped from internal and external surfaces.
 2. During fabrication and assembly, remove slag and weld spatter from both internal and external pipe joints by peening, chipping and wire brushing.
 3. Notify the Construction Manager and Commissioning Agent prior to starting any post erection cleaning operation in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Construction Manager regarding specific procedures and scheduling. Arrange for proper disposal of cleaning and flushing fluids.

END OF SECTION

SECTION 232216 - STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Strainers.
 - 2. Steam traps.
 - 3. Flexible connectors.
 - 4. Steam meters.
- B. Related Requirements:
 - 1. Section 230523 "General Duty Valves for HVAC Piping" for specification and installation requirements for globe, ball, butterfly, check, and gate valves.

1.03 ACTION SUBMITTALS

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

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product.

1.05 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
 - 1. ASME Compliance: Safety valves and pressure vessels to bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Components and installation to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

1. High-Pressure Steam Piping: >15 psig.
2. Low-Pressure Steam Piping: < = 15 psig.

2.02 STRAINERS

A. Y-Pattern Strainers, Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Keckley Company.
 - c. Metraflex Company (The).
 - d. Mueller Steam Specialty; A Watts Water Technologies Company.
 - e. Spirax Sarco Limited.
 - f. Titan Flow Control, Inc.
2. Body: ASTM A126, Class B cast iron, with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for strainers NPS 2 and smaller; flanged ends for strainers NPS 2-1/2 and larger.
4. Strainer Screen: Stainless steel, 20 40 60 Insert number-mesh strainer or perforated stainless steel basket.
5. Tapped blowoff plug.
6. Rating: 250 psig working steam pressure.

2.03 STEAM TRAPS

A. Steam Traps, Float and Thermostatic Type - Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Hoffman Specialty; Bell & Gossett, a xylem brand.
 - d. Spirax Sarco Limited.
 - e. Sterling.
 - f. Tunstall Corporation.
2. Body and Bolted Cap: ASTM A126 cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Maximum Operating Pressure: 125 psig.

B. Steam Traps, Inverted Bucket Type - Cast Iron:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Armstrong International, Inc.
 - b. Barnes & Jones, Inc.
 - c. Hoffman Specialty; Bell & Gossett, a xylem brand.
 - d. Spirax Sarco Limited.
 - e. Sterling.
 - f. Tunstall Corporation.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless steel inlet strainer within the trap body.
8. Air Vent: Stainless steel thermostatic vent.
9. Pressure Rating: 250 psig.

2.04 FLEXIBLE CONNECTORS

A. Flexible Connectors, Bellows Type - Stainless Steel:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Duraflex, Inc.
 - b. Flexicraft Industries.
 - c. Hyspan Precision Products, Inc.
 - d. Mason Industries, Inc.
 - e. Metraflex Company (The).
 - f. Twin City Hose, Inc.
2. Body: Stainless steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
3. End Connections: Threaded or flanged to match equipment connected.
4. Performance: Capable of 3/4-inch misalignment.
5. CWP Rating: 150 psig.
6. Maximum Operating Temperature: 250 deg F.

2.05 STEAM METERS

A. Manufacturers: See 230519 - METERS AND GAGES FOR HVAC PIPING

- ### B. Meters to 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 to 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.

PART 3 - EXECUTION

3.01 VALVE APPLICATIONS

- A. Install shutoff duty valves to isolate meters from steam supply on mains and at the outlet of steam traps.

3.02 INSTALLATION OF STEAM AND CONDENSATE HEATING PIPING SPECIALTIES

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full-port ball valve, and short NPS 3/4 threaded nipple with cap, at low points as required for system drainage but not within the required straight pipe length before and after the meters.
- C. Install valves in accordance with Section 230523 "General Duty Valves for HVAC Piping."
- D. Install unions in piping, NPS 2 and smaller, adjacent to valves.
- E. Install flanges in piping, NPS 2-1/2 and larger, at valves and meters.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on inlet side of traps. Match size of strainer blowoff connection for strainers smaller than NPS 2.

3.03 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.

3.04 INSTALLATION OF STEAM AND STEAM CONDENSATE METERS

- A. Install steam and with lengths of straight pipe upstream and downstream according to meter manufacturer's written instructions.
- B. See Section 230923 "Direct Digital Control (DDC) System for HVAC" for data acquisition wiring.

END OF SECTION 232216

SECTION 260000 ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 GENERAL

- A. All provisions of the "Instructions to Bidders", "Conditions of Contract", "General Conditions", "Special Conditions", Division 1 of "General Specifications" and applicable work in the "Electrical Requirements Section" govern work under the contract.
- B. Provide all items, articles, materials, operations, or methods listed, mentioned or scheduled in the contract documents and/or specified herein, including all labor, materials, equipment and incidentals necessary and required for their completion. The complete installation as a whole shall be left ready for satisfactory operation.

1.03 SCOPE

- A. Requirements specified herein shall govern applicable portions of the Electrical Work Sections; hereinafter referred to as Electrical Sections; whether so stated therein or not.
- B. The Contractor shall lay out his own work and assume responsibility for all lines, elevations, inverts and measurements of work executed by him under the contract. He shall exercise every precaution to verify figures shown in the contract documents before laying out work and shall be responsible for any error resulting from his failure to exercise such precautions.
- C. Where items specified in the Electrical Sections of the Specifications conflict with requirements in this section, the former shall govern.

1.04 REFERENCES

- A. References to standards, codes, specifications or recommendations shall mean the latest edition of such publications adopted and published at date of invitation to submit proposals.

1.05 DEFINITIONS

- A. Following definitions of terms and expressions used in the electrical sections are in addition to listing given in Supplementary General Conditions:
 - 1. "Provide" shall mean "furnish and install".
 - 2. "Herein" shall mean the contents of a particular section where this term appears.
 - 3. "Indicated" shall mean "indicated on contract drawings".
 - 4. "Section" shall mean one of the following portions of the Electrical Specifications.

5. "Subsection" shall mean portions of Sections as listed under "Index" at the beginning of each Section.
6. "Concealed" shall mean hidden from sight, as in trenches, chases, furred spaces, pipe shafts or hung ceilings.
7. "Exposed" shall mean that they are not "Concealed" as defined herein above.
8. "Conduit" includes in addition to conduit, also fittings, hangers, other accessories which comprise a system.
9. "Electrician" shall mean the Contractor (or subcontractor) for Electrical Work.
10. "Contractor" shall mean the Electrical Contractor (or subcontractor) for Electrical Work.
11. "Singular Number". In all cases where a device or part of the equipment or system is herein referred to in the singular number it is intended that such reference shall apply to as many such items as are required to complete the installation.
12. "Remove" shall mean "disconnect, remove and legally dispose of when not indicated to be reused".

1.06 DRAWINGS, INSTRUCTIONS

- A. Contract drawings for electrical work are in part diagrammatic, and are intended to convey the scope of work and indicate general arrangement of equipment, conduits, approximate sizes and locations of equipment and outlets. The Contractor shall follow these drawings in laying out his work, shall consult general construction drawings to familiarize themselves with all conditions affecting their work, and shall verify spaces in which their work will be installed.
- B. Where job conditions require reasonable changes such as indicated locations and/or equipment arrangement, such changes shall be made without extra cost to Department. This is not to be construed as to permit redesigning of the various systems.
- C. Additional and supplementary drawings may, from time to time, be furnished and the same when made, are to constitute a part of the original contract. These drawings will be made to clarify the contract drawings and will not depart materially therefrom.

1.07 CODES AND ORDINANCES AND REGULATIONS

- A. Nothing contained in the specifications or shown in the contract documents are intended to conflict with the codes, laws, ordinances, rules or regulations of Federal, State or Local Municipal Departmental Authorities having jurisdiction over the premises, the National Board of Fire Underwriters Inspection Agency and the Department's Insuring Agency. All such codes, laws, ordinances, rules and regulations are hereby incorporated and made a part of these specifications. Fixtures, appliances and equipment which are subject to UL tests shall bear such approval. All work performed on this project and all equipment furnished for this project shall be in conformance with the regulations and requirements of the Occupational Safety and Health Act (OSHA).
- B. Should any change in the contract documents and/or specifications be required to conform to the codes, ordinances, regulations or laws mentioned above, the Design Professional shall be notified prior to the time of submitting bids. After signing of the Contract, the Contractor will be responsible for the completion of all work necessary to meet the above mentioned requirements without additional expense to the Department.
- C. Obtain and pay for all permits, inspections, test and certificates relating to his work as required by any of the foregoing Authorities. All certificates shall be delivered to the Design Professional and become the property of the Department.

- D. Upon completion of the work, furnish to the Engineers an Underwriter's Certificate of inspection indicating full approval of the work furnished and installed in the project.
- E. Observe such rules and regulations as may be instituted by the Department, Design Professional or their representatives affecting the conduct of employees, and the use and safeguarding of property.

1.08 LINES AND GRADES

- A. The Contractor shall lay out his work and be responsible for lines, elevations, measurements, required for installation of his work.

1.09 OBJECTIONABLE NOISE AND VIBRATION

- A. Electrical equipment shall operate without objectionable noise or vibration as determined by Engineer.
- B. If objectionable noise or vibration is produced and transmitted to occupied portions of the building by the apparatus, due to poor workmanship, and/or omission of vibration isolators, shock absorbers, etc., the Contractor involved shall make necessary changes and additions, as approved and/or required, without additional cost to the Department.

1.10 EQUIPMENT DESIGN AND INSTALLATION

- A. Uniformity: Unless otherwise specified, equipment or material of the same type or classification, and used for the same purpose shall be of the same manufacturer. All material shall be new and of the latest design of the manufacturer providing the equipment or material.
- B. Design: Equipment and accessories not specifically described or identified by the manufacturer's catalog numbers shall be designed in conformity with NEMA or other applicable technical standards and shall be suitable for maximum working pressure and shall have a neat and finished appearance.
- C. Installation: Erect equipment in a neat and workmanlike manner; align, level and adjust as required for satisfactory operation; install so that disconnecting can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made only after obtaining approval from the Design Professional and Engineers.

1.11 PROTECTION OF EQUIPMENT AND MATERIALS

- A. The following is in addition to Protection of Work and Property, in Conditions of Contract:
 - 1. Responsibility for care and protection of electrical work rests with the contractor until it has been tested and accepted.
 - 2. After delivery, before and after installation, protect all equipment and materials against theft, injury and damage from all causes.
 - 3. Protect equipment outlets and conduit openings with caps.
 - 4. Protect existing equipment which is to remain.

1.12 HANDLING OF EQUIPMENT AND MATERIALS

- A. The Contractor shall receive, properly house, handle, hoist, and deliver to proper location, all equipment and other material required for his contract.

1.13 WEATHERPROOF EQUIPMENT

- A. All electrical equipment exposed to the weather and/or high humidity areas shall be of the rain tight or weatherproof construction, whether specified or not, and of NEMA type as outlined by the National Electrical Code and/or as called for in the contract documents.

1.14 ACCESSIBILITY OF ELECTRICAL EQUIPMENT

- A. It shall be the Contractor's responsibility to see that all electrical equipment such as junction boxes, pull boxes, panelboards, switches, controls and other apparatus as may require maintenance and operation from time to time are easily accessible.

1.15 EXISTING CONDITIONS TO BE VERIFIED

- A. The data so indicated or inferred to as existing conditions are not intended as representations or warranties of accuracy of construction and existing conditions.
- B. The data is made available for the convenience of the Contractor. The Contractor shall make all necessary additional field surveys and check all existing conditions prior to submitting his proposal at no cost to the Department and with the Department's approval.
- C. The exact location of utilities and services is not guaranteed nor is there any guarantee that all existing utilities, services, shafts, structures, functional or abandoned are shown.
- D. The Contractor shall verify in the field all dimensions, structures, services, whether or not shown in the contract documents. The Contractor shall field measure all conditions at the site and be responsible for their correctness. No extra charge or compensation will be allowed on account of any difference between actual dimensions and any measurements indicated on drawings. Any difference found shall be reported to the Design Professionals and Department in sufficient time for their consideration and direction before proceeding with the work involved.

1.16 SUPERINTENDENCE

- A. The Contractor shall give his personal superintendence to the work or have a competent superintendent, satisfactory to the Design Professional, on the work at all times, during construction, with authority to act for him. He shall provide an adequate organization for proper coordination and expediting of his work.

1.17 SCAFFOLDING

- A. The Contractor shall furnish and install scaffolding ladders and runways as required in connection with his work.

1.18 SAFETY

- A. The Contractor shall furnish and place necessary guards for the prevention of accidents. They shall provide and maintain any necessary construction required to secure safety to life or property.

1.19 CUTTING, PATCHING, RESTORING

- A. All cutting and patching required in existing construction shall be done by the Contractor. Patching shall also include repairing of walls, floors, ceilings, etc. where existing equipment has been removed. The Contractor shall not do any cutting that may impair the strength of the building construction. No holes, except for small screws, may be drilled in beams or other structure members, without obtaining prior approval. The Contractor shall restore work of other contractors damaged by him. Any cutting and patching required in new construction due to errors, defective or ill-timed work or tardiness on the part of the contractor to designate sizes and locations to the General Contractor in sufficient time shall be paid for by the Contractor.

1.20 TEMPORARY OPENINGS

- A. Temporary openings are not indicated in the contract documents but may be required for the purpose of bringing equipment into the building. A General Construction Contractor shall perform the work of providing, maintaining and of restoring the structure. The Electrical Contractor for whom the temporary opening is provided shall bear all costs thereof, including restoring the structure. Ample notice shall be given to the General Contractor as to the size and location of such temporary openings. Holes provided in General Construction work to permit installation of lines for temporary electrical service will, after removal of such lines, be patched by the Contractor.

1.21 REMOVAL OF RUBBISH

- A. Periodically, and at the completion of the work contemplated under these specifications, the Contractor shall remove from the building and site all rubbish and accumulated materials of whatever nature and shall leave the work in a clean, orderly and acceptable condition. In addition, at the conclusion of the Project, and before the work is deemed ready for final inspection, the Contractor shall clean all items of paint splashes, grease stains, dust, finger marks, and all other unsightly marks.

1.22 GUARANTEE

- A. In addition to the requirements listed hereinbefore and stated in the individual work sections, the Contractor must guarantee all materials and apparatus installed by him to be free from defects in construction and workmanship for a period of one (1) year after acceptance of the work.

1.23 FIRE STOPPING SYSTEM

- A. The Contractor shall furnish and install all labor and materials necessary for the completion of fire stopping work as required for all conduit, cable, wiring, cable trays or similar through-penetrations of fire resistive walls, floors, floor-ceiling or roof-ceiling assemblies.

- B. All materials and application procedures shall have been tested and classified by U.L. and approved by Factory Mutual for the assembly.
- C. The Fire Stopping System shall have been tested in accordance with the procedures of ASTM E814-81 (U.L. 1479-1983) and shall be U.L. classified and Factory Mutual approved as a Through-Penetration Fire Stop System.
- D. Contractor shall submit manufacturer's specifications and installation instructions for type of fire stopping required including data showing compliance with requirements.

1.24 ACCESS DOORS

- A. Unless otherwise specified the Contractor shall provide access panels for concealed lighting fixtures, junction boxes, and other parts requiring accessibility for operation and maintenance.

1.25 PAINTING AND FINISHING

- A. All items of equipment rusted or marred even though factory finished shall be repainted.
- B. Touch-up painting of work marred by respective trades shall be done by the respective Contractor to the satisfaction of the Design Professional. Respective trades shall bear all costs involved.

1.26 EQUIPMENT IDENTIFICATION

- A. All items of electrical equipment such as distribution equipment, switches, etc., shall be identified by approved nameplates provided by contractor furnishing equipment.
- B. Nameplates shall be securely affixed to each individual piece of equipment.

1.27 SPECIAL ENGINEERING SERVICES

- A. In the instance of complex or specialized electrical systems such as fire alarm, T.V., sound systems, etc. or similar miscellaneous systems; the installation, final connections and testing of such systems shall be made under the direct supervision of competent and authorized service engineers who shall be in the employ of the respective equipment manufacturer. Any and all expenses incurred by these equipment manufacturers' representatives shall be borne by the Contractor.

1.28 WIRE GAUGE

- A. The sizes of conductors and thickness of metals shown in the contract documents or specified herein, shall be understood to be American Wire Gauge for copper wire and United States Gauge for metals.

1.29 TESTS - ELECTRICAL

- A. At the time of the final inspection, all connections at panels and switches and all splices must be made; all fuses shall be in place and all circuits continuous from point of service connections

to switches, receptacles, outlets, etc.

- B. Upon completion of the work, all parts of the electrical installation shall be tested and proved free of unwanted grounds and other defects. Preliminary testing with magneto will be permitted but will not be accepted in obtaining final results. Final tests shall be accomplished by use of a megger.
- C. All overload devices, including equipment furnished under other contracts, shall be set and adjusted to suit the load conditions.
- D. Insulation resistance on switchgear and panelboards shall be at least one (1) megohm. The insulation resistance between conductors and ground, based on maximum load, shall be not less than the requirements of the National Electrical Code.

1.30 RESPONSIBILITY FOR DAMAGE

- A. The Contractor at his own expense shall make good to the Design Professional's satisfaction any damage to his or any work incurred by the action of the elements or any other cause due to neglect on the part of the Contractor or his workmen.

1.31 EQUIPMENT FOUNDATIONS

- A. The Contractor shall provide all concrete foundations required for equipment furnished under these specifications unless otherwise noted in the contract documents or in the specifications.
- B. All foundations shall be built to templates and reinforced as required by the load to be imposed upon them.
- C. The Contractor shall furnish shop drawings showing size and location, in detail, for all foundations for equipment, for approval before any construction is begun, and shall assume all responsibility for the size and location of all foundations.

1.32 MISCELLANEOUS IRON WORK

- A. The Contractor shall furnish and install necessary structural supporting steel for supports of all suspended equipment, lighting fixtures and all other equipment furnished by him requiring support steel and for equipment as noted in the contract documents.

1.33 ROOF AND WALL OPENINGS

- A. Roof and wall openings and flashing for electrical conduits and other items which penetrate the walls and roof shall be by the Contractor. Unless otherwise noted counter-flashing required for all items shall be by the Contractor.

1.34 CUTTING AND PATCHING

- A. The Contractor shall do, or cause to be done under his supervision, all cutting, patching, repairing, altering and refinishing of construction and finishes as required by the operations of all trades and subcontractors so as to leave all constructions and finishes complete and in a condition that is satisfactory to the Design Professional and Department.

- B. Cutting and patching shall be avoided by every means possible and to this end, the Contractor shall closely coordinate and supervise the work of all trades and subcontractors.
- C. Cutting and patching shall be neatly and carefully done in a thorough and workmanlike manner. Patches and repairs shall be as inconspicuous as possible, and shall be subject to approval by the Design Professional and Department. Any contractor cutting and/or altering existing construction shall be responsible to repair, patch and refinish such work.
- D. Any extra cost caused by defective, ill-timed or premature work, or the refusal of any trade or contractor to cooperate, to provide or complete any portion of his respective work at the proper time and in the proper manner, shall be borne by the party responsible for causing the extra cost and not by the Department.
- E. All upper level work requiring cutting and patching or penetration of floor slab shall include all patching and repair of floor slab and all patching, repair and replacement of any disturbed lower level ceiling work.

1.35 EXISTING CONDITIONS (REMOVAL OF ABANDONED MATERIALS AND/OR EQUIPMENT)

- A. Unless otherwise noted in the contract documents, the Contractor shall remove from their present locations in the renovated areas, and from the premises, all existing equipment not applicable to the new installation or as indicated in the contract documents and required to accomplish the new installation.
- B. The Contractor shall remove all existing conduit, electrical equipment and all other items not applicable to the revised installation and/or as indicated in the contract documents.
- C. Unless otherwise noted in the contract documents, or in the specifications, all existing equipment to be removed is to become the property of the Contractor and shall be removed from the premises and disposed of by the Contractor. The Contractor shall verify if Department wishes to retain any equipment before removing from site.
- D. All abandoned conduits, etc., which run concealed shall be cut off below floor or above ceiling, as required.
- E. The Contractor shall disconnect any service to this equipment, prior to removal.
- F. Where existing circuits in other areas of the building are partially affected by the renovations; and continuity of service must be maintained in the remainder of the circuit, conductors shall be properly spliced and taped and said outlets where necessary shall be extended to the new finished surfaces in order to maintain accessibility to the outlet.

1.36 INTERRUPTION OF ELECTRICAL SERVICE

- A. The Contractor's attention is called to the fact that the existing facilities must remain in operation during the construction period. In view of this, the Electrical Contractor shall maintain services for these facilities until such time that the new services are installed, energized and ready for connecting.
- B. All work shall be done in such time and manner as will least interfere with the maintenance and operation of all related or affected existing electrical systems. Provisions must be made to permit the use of all systems at all times by the Client Agency. Any interruptions to systems required to perform the work shall be pre-arranged, in advance, with the Client Agency. The

Contractor shall provide temporary services as required to accomplish this.

1.37 TEMPORARY POWER AND LIGHT

- A. The Contractor shall provide all necessary wiring facilities for temporary electricity required for construction purposes.

1.38 TEMPORARY MEDICAL SERVICE AND FIRST AID

- A. The Contractor shall provide and maintain medical services and first aid all in accordance with the regulations of OSHA, Department of Labor, Chapter 17, Part 1926, Subpart D, Section 1926.50.

1.39 OTHER SAFETY MEASURES

- A. The Contractor shall comply with all other applicable OSHA requirements for the safety in building construction which are not specifically mentioned in this Section of the Specifications.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION - Not Applicable.

END OF SECTION

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 600 V or less.
 - 3. Fire-alarm wire and cable.
 - 4. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.03 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer's authorized service representative.
- B. Field quality-control reports.

1.06 QUALITY CONTROL

- A. Testing Agency Qualifications: Member company of NETA.

PART 2 - PRODUCTS

2.01 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Alpha Wire Company.
 - 2. American Bare Conductor.
 - 3. Belden Inc.
 - 4. Cerro Wire LLC.
 - 5. Encore Wire Corporation.
 - 6. General Cable Technologies Corporation.
 - 7. Okonite Company (The).
 - 8. Service Wire Co.
 - 9. Southwire Company.
 - 10. 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. RoHS compliant.
 - 3. 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 B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
 - 2. Type THHN and Type THWN-2: Comply with UL 83.
 - 3. Type XHHW-2: Comply with UL 44.
- F. Shield:
 - 1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.02 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. 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. AFC Cable Systems; a part of Atkore International.
2. Alpha Wire Company.
3. American Bare Conductor.
4. Belden Inc.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. Okonite Company (The).
8. Service Wire Co.
9. Southwire Company.
10. 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. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Bare.

G. Conductor Insulation:

2.03 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. Comtran Corporation.
4. Draka Cabletek USA; a Prysmian Group company.
5. Genesis Cable Products; Honeywell International, Inc.
6. Radix Wire.
7. Rockbestos-Suprenant Cable Corp.
8. Superior Essex Inc.
9. 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, No. 18 AWG.

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.

2.04 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. 3M Electrical Products.
 2. AFC Cable Systems; a part of Atkore International.
 3. Gardner Bender.
 4. Hubbell Power Systems, Inc.
 5. Ideal Industries, Inc.
 6. ILSCO.
 7. NSi Industries LLC.
 8. O-Z/Gedney; a brand of Emerson Industrial Automation.
 9. Service Wire Co.
 10. TE Connectivity Ltd.
 11. Thomas & Betts Corporation; A Member of the ABB Group.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 1. Material: Copper.
 2. Type: Two hole with standard barrels.
 3. Termination: Compression.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
- F. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC.
- E. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- F. VFC Output Circuits: Type TC-ER cable with braided shield.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- 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."

3.04 INSTALLATION OF FIRE-ALARM WIRING

- A. Comply with NECA 1 and 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 shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:

1. 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 shall not be installed in the same cable or pathway as signaling line circuits.
- D. 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.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- F. 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.
- 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.

3.05 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 6 inches of slack.
- D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.06 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.

3.07 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."

3.08 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."

3.09 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors feeding the following critical equipment and services for compliance with requirements:
 - 3. 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.
 - 4. 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.
- 5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- 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.

END OF SECTION

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Balanced twisted pair cabling hardware.
 - 3. RS-485 cabling.
 - 4. Low-voltage control cabling.
 - 5. Control-circuit conductors.
 - 6. Identification products.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 QUALITY CONTROL

- A. Testing Agency Qualifications: Accredited by NETA.

PART 2 - PRODUCTS

2.01 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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.02 BACKBOARDS

- A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."
- B. Painting: Paint plywood on all sides and edges with black paint. Comply with requirements in Section 099123 "Interior Painting."

2.03 BALANCED TWISTED PAIR CABLE HARDWARE

- 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. 3M.
 - 2. American Technology Systems Industries, Inc.
 - 3. AMP NETCONNECT; a TE Connectivity Ltd. company.
 - 4. Belden CDT Networking Division/NORDX.
 - 5. Berk-Tek Leviton; a Nexans/Leviton alliance.
 - 6. CommScope, Inc.
 - 7. Draka USA.
 - 8. Dynacom Corporation.
 - 9. General Cable; General Cable Corporation.
 - 10. Genesis Cable Products; Honeywell International, Inc.
 - 11. Hubbell Premise Wiring.
 - 12. KRONE Incorporated.
 - 13. Leviton Manufacturing Co., Inc.
 - 14. Mohawk; a division of Belden Networking, Inc.
 - 15. Molex Premise Networks.
 - 16. Panduit Corp.
 - 17. Siemon Co. (The).

18. Superior Essex Inc.
19. SYSTIMAX Solutions; a CommScope Inc. brand.

B. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6 .
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

2.04 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, two 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.

2.05 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Multi-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Multi-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.

2.06 CONTROL-CIRCUIT CONDUCTORS

- 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. Encore Wire Corporation.
 2. General Cable; General Cable Corporation.
 3. Service Wire Co.
 4. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 1. Smoke control signaling and control circuits.

2.07 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. Comtran Corporation.
 4. Draka Cabletek USA; a Prysmian Group company.
 5. Genesis Cable Products; Honeywell International, Inc.
 6. Radix Wire.
 7. Rockbestos-Suprenant Cable Corp.
 8. Superior Essex Inc.
 9. 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.

2.08 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Test cables on receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

3.02 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
 - 2. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
 - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard if entering the room from overhead.
 - 4. Extend conduits 3 inches above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
2. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
3. Cables serving a common system may be grouped in a common raceway. Do not group conductors from different systems or different voltages.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
7. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
8. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. 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 or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.05 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits; No 14 AWG.
 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.06 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.07 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.08 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.
- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.09 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- 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 tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 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. Intersystem bonding bridge grounding connector.
 - 6. Grounding and bonding busbars.
 - 7. Grounding (earthing) electrodes.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product indicated.
- B. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:
 - 1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Rod electrodes.
 - 3) Ring electrodes.
 - 4) Grounding arrangements and connections for separately derived systems.
 - b. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS .

- 1) Tests must determine if ground-resistance or impedance values remain within specified maximums, and instructions must recommend corrective action if values do not.
- 2) Include recommended testing intervals.

PART 2 - PRODUCTS

2.01 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. 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. ERICO; brand of nVent Electrical plc.
 - b. Harger Lightning & Grounding; business of Harger, Inc.
 - c. Approved equal.
2. 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.

2.02 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; see Section 270526 "Grounding and Bonding for Communications Systems," for selection and installation guidelines.

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.

D. UL KDER - Exothermically Welded Connection :

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. ALLTEC LLC.
 - c. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - d. Crouse-Hinds; brand of Eaton, Electrical Sector.
 - e. ERICO; brand of nVent Electrical plc.
 - f. Harger Lightning & Grounding; business of Harger, Inc.
 - g. Approved equal.
2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 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.
- D. UL KDER - Bonding Bushing:
 1. General Characteristics: Threaded bushing with insulated throat.
- E. UL KDER - Grounding Bushing :
 1. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.04 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.

2.05 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- 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 for Communications: UL CCN KDSH; including UL 467.
- C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
 - 1. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.

2.06 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.

D. UL KDER - Equipment Room Grounding and Bonding Busbar :

1. General Characteristics:

- a. Bus: Rectangular bar of annealed copper.
- b. Mounting Stand-Off Insulators: Lexan or PVC.
 - 1) Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

2.07 GROUNDING (EARTHING) ELECTRODES

A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.

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.

D. UL KDER - Rod Electrode :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. ABB, Electrification Business.
- b. ERICO; brand of nVent Electrical plc.
- c. Galvan Industries, Inc.; Electrical Products Division, LLC.
- d. Harger Lightning & Grounding; business of Harger, Inc.
- e. Approved equal.

2. General Characteristics: Copper-clad steel; 3/4 inch by 10 ft.

PART 3 - EXECUTION

3.01 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.

3.02 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.

3.03 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.
- G. Underground Grounding Conductors: Install bare tinned-copper conductor, 2/0 AWG minimum.
 - 1. Bury at least 30 inch below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.

3.04 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.05 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. 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. Grounding and Bonding for Piping:
- 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft apart.
3. Electrodes:
- a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
4. Grounding at Service:
- a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.
5. Grounding Separately Derived Systems:

- a. Generator: Install grounding electrode(s) at generator location. Electrode must be connected to equipment grounding conductor and to frame of generator.
6. Grounding Underground Distribution System Components:
- a. Duct-Bank Grounding Conductor: Bury 12 inch above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch above to 6 inch below concrete. Seal floor opening with waterproof, nonshrink grout.
 - d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
7. Equipment Grounding:
- a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.
 - 5) Three-phase motor and appliance branch circuits.
 - 6) Flexible raceway runs.
 - 7) Armored and metal-clad cable runs.
 - c. Air-Duct Equipment Circuits: Install 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.
 - d. 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.
 - e. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.06 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Architect.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

D. Collect, assemble, and submit test and inspection reports.

3.07 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems.
 - 2. Conduit and cable support devices.
 - 3. Support for conductors in vertical conduit.
 - 4. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.03 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. Fasteners.
 - e. Anchors.
 - f. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.

1.04 QUALITY CONTROL

- A. Welding Qualifications: As applicable, qualify procedures and personnel according to AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D 635.

2.02 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 inches o.c. in at least one surface.
 - 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; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. CADDY; a brand of nVent.
 - d. Flex-Strut Inc.
 - e. Gripple Inc.
 - f. GS Metals Corp.
 - g. G-Strut.
 - h. Haydon Corporation.
 - i. Metal Ties Innovation.
 - j. MIRO Industries.
 - k. Thomas & Betts Corporation; A Member of the ABB Group.
 - l. Unistrut; Part of Atkore International.
 - m. Wesanco, Inc.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: Selected for applicable load criteria .
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- B. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 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) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
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: All -steel springhead type.
7. Hanger Rods: Threaded steel.

2.03 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

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA 101
 3. NECA 105.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. 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.

- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor 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 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.04 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches 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.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
 - 2. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
 - 3. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.03 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.
- B. IMC: Intermediate metal conduit.
- C. EMT: Electrical metallic tubing.

1.04 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

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. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.
 - e. Electri-Flex Company.
 - f. FSR Inc.
 - g. Korkap.
 - h. Opti-Com Manufacturing Network, Inc (OMNI).
 - i. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - j. Patriot Aluminum Products, LLC.
 - k. Perma-Cote.
 - l. Picoma Industries, Inc.
 - m. Plasti-Bond.
 - n. Republic Conduit.
 - o. Southwire Company.
 - p. Thomas & Betts Corporation; A Member of the ABB Group.
 - q. Topaz Electric; a division of Topaz Lighting Corp.
 - r. Western Tube and Conduit Corporation.
 - s. Wheatland Tube Company.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. EMT: Comply with ANSI C80.3 and UL 797.
5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal 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. AFC Cable Systems; a part of Atkore International.
 - b. Allied Tube & Conduit; a part of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Calconduit.
 - e. Electri-Flex Company.
 - f. FSR Inc.
 - g. Korkap.
 - h. Opti-Com Manufacturing Network, Inc (OMNI).

- i. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - j. Patriot Aluminum Products, LLC.
 - k. Perma-Cote.
 - l. Picoma Industries, Inc.
 - m. Plasti-Bond.
 - n. Republic Conduit.
 - o. Southwire Company.
 - p. Thomas & Betts Corporation; A Member of the ABB Group.
 - q. Topaz Electric; a division of Topaz Lighting Corp.
 - r. Western Tube and Conduit Corporation.
 - s. Wheatland Tube Company.
- 2. Comply with NEMA FB 1 and UL 514B.
- 3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 4. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 5. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
- 6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- 7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.
 - 1. Condux International, Inc.
 - 2. Niedax Inc.
 - 3. Topaz Electric; a division of Topaz Lighting Corp.
 - 4. Condux International, Inc.
 - 5. Niedax Inc.
 - 6. Topaz Electric; a division of Topaz Lighting Corp.

2.02 METAL WIREWAYS AND AUXILIARY GUTTERS

- 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. B-line, an Eaton business.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. MonoSystems, Inc.
 - 4. SquareD.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters,

hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.03 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
 - 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. Hubbell Incorporated; Wiring Device-Kellems.
 - b. MonoSystems, Inc.
 - c. Panduit Corp.
 - d. Wiremold / Legrand.

2.04 BOXES, ENCLOSURES, AND CABINETS

- 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. Adalet.
 - 2. Crouse-Hinds, an Eaton business.
 - 3. EGS/Appleton Electric.
 - 4. Erickson Electrical Equipment Company.
 - 5. FSR Inc.
 - 6. Hoffman; a brand of Pentair Equipment Protection.
 - 7. Hubbell Incorporated.
 - 8. Hubbell Incorporated; Wiring Device-Kellems.
 - 9. Kraloy.
 - 10. Milbank Manufacturing Co.
 - 11. MonoSystems, Inc.
 - 12. Oldcastle Enclosure Solutions.
 - 13. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 14. Plasti-Bond.
 - 15. RACO; Hubbell.
 - 16. Spring City Electrical Manufacturing Company.
 - 17. Stahlin Non-Metallic Enclosures.
 - 18. Thomas & Betts Corporation; A Member of the ABB Group.
 - 19. Topaz Electric; a division of Topaz Lighting Corp.
 - 20. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- G. Gangable boxes are prohibited.
- H. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- I. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
 - a. Below 8' in areas used for traffic of vehicles, mechanized carts, forklifts, and pallet-handling units.
 - b. Mechanical rooms.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet

- locations.
- 6. Damp or Wet Locations: GRC.
- 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 - 3. EMT: Compression, steel fittings. Comply with NEMA FB 2.10.
 - 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Install surface raceways only where indicated on Drawings.

3.02 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.
- D. Do not fasten conduits onto the bottom side of a metal deck roof.
- E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- F. Complete raceway installation before starting conductor installation.
- G. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install

conduits parallel or perpendicular to building lines.

- K. Support conduit within 12 inches of enclosures to which attached.
- L. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to RNC, Type EPC-40-PVC, before rising above floor.
- M. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- U. Surface Raceways:
 - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with

listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Conduit extending from interior to exterior of building.
 4. Conduit extending into pressurized duct and equipment.
 5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 6. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Y. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. 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.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- AA. 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.

- BB. 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.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set metal floor boxes level and flush with finished floor surface.
- HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install Osleeves 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."

3.04 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.05 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

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:

- 1. Round sleeves.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Foam sealants.

- 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.

1.03 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ROUND SLEEVES

- A. Steel Wall Sleeves:

- 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. Advance Products & Systems, LLC.
 - b. CCI Piping Systems.
 - c. Flexicraft Industries.
 - d. GPT; an EnPro Industries company.
 - 2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.

2.02 SLEEVE-SEAL SYSTEMS

- 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. Advance Products & Systems, Inc.
 - 2. BWM Company.
 - 3. CALPICO, Inc.
 - 4. Flexicraft Industries.
 - 5. GPT; a division of EnPRO Industries.
 - 6. Metraflex Company (The).
 - 7. Proco Products, Inc.
- B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C. Options:
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.03 SLEEVE-SEAL FITTINGS

- 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. HoldRite; Reliance Worldwide Company.
 - 2. Insert manufacturer's name.
- B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 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.

2.05 FOAM SEALANTS

- 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. Dow Chemical Company (The).
2. Innovative Chemical Products (Building Solutions Group).

B. Performance Criteria:

1. General Characteristics: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.01 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.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inch above finished floor level. Install sleeves during erection of floors.

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 steel 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.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

2. Install steel pipe sleeves. Size sleeves to allow for 1 inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

3.02 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:

1. Labels.
2. Tags.
3. Signs.
4. Cable ties.

1.04 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 electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

- E. Comply with NFPA 70E requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
 - 1. Insert color scheme.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - 4. Color for Neutral: White.
 - 5. Color for Equipment Grounds: Green.
 - 6. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
 - 1. Black letters on an orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- E. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- F. Equipment Identification Labels:

1. Black letters on a white field.

2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 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. Brady Corporation.
 - b. Champion America.
 - c. emedco.
 - d. Grafoplast Wire Markers.
 - e. HellermannTyton.
 - f. LEM Products Inc.
 - g. Marking Services, Inc.
 - h. Panduit Corp.
 - i. Seton Identification Products.
- 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.
 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. Brady Corporation.
 - b. HellermannTyton.
 - c. Marking Services, Inc.
 - d. Panduit Corp.
 - e. Seton Identification Products.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 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. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. Ideal Industries, Inc.
 - g. LEM Products Inc.
 - h. Marking Services, Inc.
 - i. Panduit Corp.
 - j. Seton Identification Products.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
 3. Marker for Labels:
 - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
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. A'n D Cable Products.
 - b. Brady Corporation.
 - c. Brother International Corporation.
 - d. emedco.
 - e. Grafoplast Wire Markers.
 - f. HellermannTyton.
 - g. Ideal Industries, Inc.
 - h. LEM Products Inc.
 - i. Marking Services, Inc.
 - j. Panduit Corp.
 - k. Seton Identification Products.
 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.04 TAPES AND STENCILS

- A. Underground-Line Warning Tape:
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. Brady Corporation.
 - b. Ideal Industries, Inc.
 - c. LEM Products Inc.
 - d. Marking Services, Inc.
 - e. Reef Industries, Inc.
 - f. Seton Identification Products.
 2. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.

- c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- 3. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE" Insert inscription.
- 4. Tape Type I Insert drawing designation:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Thickness: 4 mils.
 - d. Weight: 18.5 lb/1000 sq. ft..
 - e. Tensile according to ASTM D882: 30 lbf and 2500 psi.
- 5. Tape Type ID:
 - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 5 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 28 lb/1000 sq. ft..
 - f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

2.05 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.
 - 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. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
 - e. Seton Identification Products.
- B. Write-on Tags:
 - 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. Carlton Industries, LP.

- b. LEM Products Inc.
- c. Seton Identification Products.

2. Marker for Tags:

- a. Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.06 SIGNS

A. Baked-Enamel Signs:

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. Carlton Industries, LP.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
2. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

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. Brady Corporation.
 - b. Champion America.
 - c. emedco.
 - d. Marking Services, Inc.
2. 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.
3. 1/4-inch grommets in corners for mounting.
4. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

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. Brady Corporation.
 - b. Carlton Industries, LP.
 - c. emedco.
 - d. Marking Services, Inc.
2. Engraved legend.

3. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. Engraved legend with black letters on white face.
 - c. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.07 CABLE TIES

- 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. HellermannTyton.
 2. Ideal Industries, Inc.
 3. Marking Services, Inc.
 4. Panduit Corp.
- B. 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 according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- C. 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 according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- D. 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 according to ASTM D638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

PART 3 - EXECUTION

3.01 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.

3.02 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 each 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 600 V: Identification shall 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. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- M. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.

2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a 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 inches high.

O. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

P. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

Q. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

R. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using general-purpose UV-stabilized plenum-rated cable ties.

S. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a 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 inches high.

T. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a 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 inches high.

U. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a 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 inches high.

V. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 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. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, and at 10-foot maximum intervals.
- D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Vinyl wraparound labels Self-adhesive labels.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- E. Accessible Raceways and Metal-Clad Cables, 600 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-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "EMERGENCY POWER."
 - 2. "POWER."
 - 3. "UPS."
- G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.
- I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags self-adhesive labels with the conductor or cable designation, origin, and destination.
- J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- L. Auxiliary Electrical Systems Conductor Identification: 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.
- M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
 2. Wall surfaces directly external to raceways concealed within wall.
 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- O. Workspace Indication: Apply to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall 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.
- P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- Q. 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.
- R. Arc Flash Warning Labeling: Self-adhesive labels.
- S. Operating Instruction Signs: Self-adhesive labels Laminated acrylic or melamine plastic signs.
- T. Emergency Operating Instruction Signs: Baked-enamel warning signs Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- U. Equipment Identification Labels:
1. Indoor Equipment: Baked-enamel signs Metal-backed butyrate signs.
 2. Outdoor Equipment: Laminated acrylic or melamine sign.
 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, 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 the transformer, feeder, and panelboards or equipment supplied by the 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. Power-generating units.
- s. Monitoring and control equipment.
- t. UPS equipment.

END OF SECTION

SECTION 260800 - ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

STIPULATIONS

The Specifications Sections "General Conditions of Contract", "Special Conditions" and "Division 1 - General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

RELATED DOCUMENTS

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

Section 019100 - Commissioning Requirements.

All Division 26 Specification Sections apply to this Section.

SYSTEMS TO BE COMMISSIONED

The Electrical Systems that shall be commissioned in this project include the following:

Utility Metering Systems including Electrical.

Data Infrastructure Communication Systems.

PART 2 - PRODUCTS

TEST EQUIPMENT

The 0.4 Contractor shall provide all equipment necessary to fulfill the testing requirements of Division 26.

PART 3 - EXECUTION

RESPONSIBILITIES

0.4 Contractor. The commissioning responsibilities applicable to the 0.4 Contractor are as follows:

Construction and Acceptance Phase

Attend the initial commissioning meeting conducted at the start of construction, the commissioning meeting held 30 days prior to startup of the primary equipment, and all commissioning team meetings.

Provide one copy of approved shop drawings and startup reports for all commissioned equipment to the CxA. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature, which will be included in the Operation and Maintenance Manuals.

The Operation and Maintenance Manuals shall be submitted to the CxA prior to the start of training (3 weeks before start-up and training and at least 60 days before substantial completion).

During the startup and initial checkout process, execute all portions of the manufacturer's start-up checklists and prefunctional checklists for all commissioned electrical equipment. Refer to Section 01900.

Perform and clearly document all completed startup and system operational checkout procedures and prefunctional checklist providing copies to the CxA. Refer to Section 01900.

The CxA writes, coordinates, witnesses and conducts functional performance test procedures. Contractors for each trade shall provide the necessary support to the CxA to complete functional testing.

Address current Professional punch list items and Commissioning corrective action items before functional and/or acceptance testing.

Provide skilled technicians to execute starting of equipment and to perform tests in accordance with all Division 26 sections. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.

Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and Professional and retest the equipment.

Provide training of the Client Agency's operating staff using expert qualified personnel, as specified.

Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

Warranty Period

Correct deficiencies and make necessary adjustments to O&M manuals for applicable issues identified in any seasonal testing.

SUBMITTALS

Copies of electrical shop drawings will be provided to CxA, when they are submitted to the Professional, electronically through E-Builder. CxA will review shop drawings concurrently with the Professional and provide any comments to the Professional so they may be included in their comments. Copies of approved shop drawings and startup reports for all commissioned equipment will be forwarded to the CxA through E-Builder. Supplement the shop drawing data with the manufacturer's installation and start-up procedures. This material should be identical to the literature which will be included in the Operation and Maintenance Manuals.

These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Professional will approve them.

STARTUP

The 0.4 Contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section. Equipment start-up is required to complete systems and sub-systems so they are fully functional, in compliance with the Contract Documents. The commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning agent or Department.

Testing is intended to begin upon completion of a system.

TESTS

Refer to applicable Division 26 sections for a description of the process, specific details, and/or standards referenced for acceptance testing.

The Electrical Contractor (0.4 Contractor) shall complete and document all startup and acceptance testing in accordance with all Division 26 sections. In addition, provide the necessary support to execute functional testing, as directed by the CxA.

At the CxA's discretion, if large numbers or repeated deficiencies are encountered, the CxA shall suspend functional testing until the Contractor corrects the deficiencies and troubleshoots all remaining systems at issue on their own. The Contractor shall be responsible for any resulting schedule delays that increase the overall time period to complete functional testing.

WRITTEN WORK PRODUCTS

Written work products of 0.4 Contractor will consist of the filled out start-up, initial checkout, pre-functional checklists, and test documentation in accordance with all Division 26 sections.

END OF SECTION 260800

SECTION 260913 - ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. Drawings specifications "General Conditions", "Special Requirements" and "General Requirements" form a part of this section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Integrate the existing proprietary Schneider Electric Inc, electric metering of the existing main electric services on to the Automated Logic Corporation (ALC) or the Johnson Controls Incorporated (JCI) Building Automation Systems (BAS) at the following buildings:

1. Labor and Industry (ALC)
2. Health and Welfare(ALC).
3. PA Judicial Center (JCI).
4. Finance Building (ALC)
5. Forum.(ALC)
6. Keystone(ALC)
7. North(ALC)
8. East Wing (JCI)
9. South(ALC)
10. Main Capitol (JCI)
11. Ryan (JCI)
12. Museum (JC

Sect:

1.04 iDEFINITIONS

- A. Active Power: The average power consumed by a unit. Also known as "real power."

- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. Apparent (Phasor) Power: " $S = VI$ " where "S" is the apparent power, "V" is the RMS value of the voltage, and "I" is the RMS value of the current.
- D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.
- E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.
- F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.
- G. L-G: Line to ground.
- H. L-L: Line to line.
- I. L-N: Line to neutral.
- J. MODBUS TCP/IP: An open protocol for exchange of process data.
- K. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- L. N-G: Neutral to ground.
- M. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

1.05 ACTION SUBMITTALS

- A. Product Data:
 - 1. Network Gateway, SFP modules.
- B. Shop Drawings: For power monitoring and control equipment.
 - 1. Register List (Schneider Electric).
 - 2. Software Graphic Meter Page Layouts (ALC and JCI)
 - 3. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.
 - a. Attach copies of approved Product Data submittals for products rs) that describe the following:
 - 1) Location of the meters and gateways, and routing of the connecting wiring.
 - 2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.
 - 4. Network naming and numbering scheme.
 - 5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and

- presentation with a block diagram.
- 6. Specifications for workstations.
- 7. Surge Suppressors: Data for each device used and where applied.

1.06 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.
 - a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
 - b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
 - c. As-built versions of submittal Product Data.
 - d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
 - e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
 - f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - g. Engineering, installation, and maintenance manuals that explain how to do the following:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
 - h. Documentation of programs created using custom programming language including set points, tuning parameters, and object database.
 - i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
 - j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
 - k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
 - l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
 - m. Owner training materials.

1.07 COORDINATION

- A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.
- B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.01 PROPRIETARY SYSTEM VENDORS.

- A. The following vendors are proprietary:
 1. Schneider Electric, Inc. (SE)
 - a. POC: Jeff Pitzer (717)495-2507
 2. Automated Logic Corporation (ALC)
 - a. POC: Randy Robertson (717)798-4066
 3. Johnson Control Inc. (JCI)
 - a. POC: Chris Barlow (717)712-3878
- B. The above item has been approved by the Department as a proprietary item. No other item will be accepted. Article 9, Paragraph 9.7, Substitutions of Materials, of the General Conditions to the Construction Contract does not apply to the above item.

2.02 SYSTEM DESCRIPTION

- A. Schneider Electric Inc, to make available existing metered electrical data resident on existing virtual server located in DGS Tech Park facility via MODBUS IP for monitoring over the existing ALC and JCI BAS systems.
 1. Points Monitored: The electric meters on incoming electrical services at the specified buildings shall be monitored every 15 minutes for the following:
 - a. KWH
 - b. KW Demand
 - c. KWH Peak Demand.
 - d. Power Factor
 - e. Voltage a-b
 - f. Voltage b-c
 - g. Voltage c-a
- B. Automated Logic Corporation (ALC) and Johnson Controls Incorporated (JCI) will update BAS software to monitor, display and record the electrical metering points indicated above on their respective systems. Provide graphics updates on each respective system to show above points for each building. Graphics layout shall be approved by the Facility.
- C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with UL 61010-1 and marked for intended location and application.

2.03 PERFORMANCE REQUIREMENTS

- A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.
 - 1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.
 - 2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

2.04 POWER MONITORING AND CONTROL SOFTWARE

- A. Data Storage and Data Sharing:
 - 1. Query and download logs of interval data stored on metering devices.
 - 2. Query and download logs of alarm and event data stored on metering devices.
 - 3. Query and download logs of waveform capture data stored on metering devices.
 - 4. Query and download logs of interval data generated by the software and calculated by the meters.
 - 5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
 - 6. Automatically re-arm the waveform recorders, on upload of information.
 - 7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
 - 8. Provide a facility to view historical data from archived databases.
 - 9. Support user changes to the database.
 - a. Support on-line changes while the data storage/retrieval application is running.
 - b. Suffer no interruption to its operation while changes are being made.
 - c. Require no restart once the configuration has been performed.
- B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:
 - 1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
 - 2. Plan for each building floor, showing the following:
 - a. Locations and identification of monitored and controlled electrical equipment.
 - 3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation with device identification.
 - 4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
 - 5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters, gateways and other network devices.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF POWER MONITORING AND CONTROL SYSTEMS

- A. Identification Installation:
 - 1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
 - 2. Comply with Section 271513 "Communications Copper Horizontal Cabling" for identification products and cable management system requirements for twisted pair cable, TIA-485 cable, control-voltage cable, and TIA-232 cable.
 - 3. Comply with Section 271523 "Communications Optical Fiber Horizontal Cabling" for identification products and cable management system requirements for optical-fiber cable.

3.03 GROUNDING

- A. For data communication wiring, comply with BICSI N1.
- B. For control-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.04 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Design Professional.
- B. Tests and Inspections:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of components.
 - 4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments must meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified

in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

- b. 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.

5. Power Monitoring and Control System Tests.

a. Test Analog Signals:

- 1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
- 2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
- 3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

b. Test Digital Signals:

- 1) Check digital signals using a jumper wire.
- 2) Check digital signals using an ohmmeter to test for contact making or breaking.

c. I/O Control Loop Tests:

- 1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
- 2) Test every I/O point throughout its full operating range.
- 3) Test every control loop to verify that operation is stable and accurate.
- 4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
- 5) Test and adjust every control loop for proper operation according to sequence of operation.
- 6) Test software and hardware interlocks for proper operation.
- 7) Operate each analog point at the following:
 - a) Upper quarter of range.
 - b) Lower quarter of range.
 - c) At midpoint of range.
- 8) Exercise each binary point.
- 9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument must match.
- 10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

C. Nonconforming Work:

- 1. Wiring and cabling will be considered defective if they do not pass tests and inspections.

- D. Prepare test and inspection reports.

3.05 FINAL REVIEW

- A. Submit written request via e-builder when the power monitoring and control system is ready for final review. Written request must state the following:
 - 1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
 - 2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
 - 3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
 - 4. The system is complete and ready for final review.
- B. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when deficiencies have been corrected. Repeat process until no deficiencies are reported.
- C. Final review must include a demonstration to parties participating in final review.

3.06 MAINTENANCE SERVICE

- A. Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by manufacturer's authorized service representative. Include semiannual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.

3.07 TRAINING

- A. Attendee Training Manuals:
 - 1. Provide each attendee with a color hard copy of training materials and visual presentations.
 - 2. Hard-copy materials must be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
 - 3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of hard-copy materials.
- B. On-Site Training:
 - 1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
 - 2. Instructor must provide training materials, projector, and other audiovisual equipment used in training.
 - 3. Provide as much of training located on-site as deemed feasible and practical by Owner.
 - 4. On-site training must include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.

5. The workstation provided with the system must be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.
- C. Off-Site Training:
1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
 2. Provide capability to remotely access to Project monitoring and control system for use in training.
 3. Provide a workstation for use by each attendee.
- D. At Completion of Training: Staff familiar with the system installed are capable of demonstrating operation of the system during final review.
- E. Demonstration must include, but not be limited to, the following:
1. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
 2. Trends, summaries, logs, and reports set-up for Project.
 3. Data entry to show Project-specific customizing capability including parameter changes.
 4. Step through penetration tree, display graphics, demonstrate dynamic update, and direct access to graphics.
 5. Execution of digital and analog commands in graphic mode.
 6. Spreadsheet and curve plot software and its integration with database.
 7. Online user guide and help functions.
 8. For Each Meter:
 - a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
 - b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
 - c. Wiring Labels: Match control drawings.
 - d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
 - e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.
 9. For Each Workstation:
 - a. Graphics are complete.
 - b. UPS unit, if applicable, operates.

END OF SECTION

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. General-use switches.
 - 2. General-grade duplex straight-blade receptacles.

1.03 DEFINITIONS

- A. Commercial/Industrial-Use Cord Reel: A cord reel subject to severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service-type cord.

1.04 ACTION SUBMITTALS

- A. Product Data:
 - 1. General use switches.
 - 2. General-grade duplex straight-blade receptacles.

1.05 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Single straight-blade receptacles.
 - 2. Duplex straight-blade receptacles.
 - 3. Receptacles with GFCI device.
 - 4. Spring-driven commercial/industrial-use cord reels.

PART 2 - PRODUCTS

2.01 GENERAL-USE SWITCHES, DIMMER SWITCHES, AND FAN-SPEED CONTROLLER SWITCHES

A. Toggle Switch :

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. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Leviton Manufacturing Co., Inc.
 - c. 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: As selected by architect.
 - b. Configuration:
 - 1) Extra-heavy-duty, 120-277 V, 20 A, single pole double pole three way four way.
5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.

2.02 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

A. Duplex Straight-Blade Receptacle:

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. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Leviton Manufacturing Co., Inc.
 - c. 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: As indicated on architectural Drawings.
 - b. Configuration:
 - 1) Heavy-duty, NEMA 5-20R.
- 5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
- B. Tamper-Resistant Duplex Straight-Blade Receptacle with USB Outlet to Power Class 2 Equipment :
 - 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. Arrow Hart, Wiring Devices; Eaton, Electrical Sector.
 - b. Leviton Manufacturing Co., Inc.
 - c. 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: As indicated on architectural Drawings.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R; one USB-A port; one USB-C port.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch thick, high-impact thermoplastic (nylon) with smooth finish and color matching wiring device; from same manufacturer as wiring device.
 - b. Securing Screws for Cover Plate: Metal with head color matching wallplate finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receptacles:

1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.02 DEVICE LOCATIONS

A. On-site walk-thru:

1. Coordinate exact location off all wiring devices with Architect.

3.03 SELECTION OF GFCI RECEPTACLES

- #### A. Healthcare Facilities: Unless protection of downstream branch-circuit wiring, cord sets, and power-supply cords is required by NFPA 70 or NFPA 99, provide non-feed-through GFCI receptacles.

3.04 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.

3.05 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 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."

D. Interfaces with Other Work:

1. Coordinate installation of new products with existing conditions.

3.06 FIELD QUALITY CONTROL OF SWITCHES

A. Field tests and inspections must be witnessed by the design professional.

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.

3.07 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

A. 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.

B. Nonconforming Work:

1. Device will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Assemble and submit test and inspection reports.

3.08 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

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.

1.04 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TGB: Telecommunications grounding busbar.
- C. TMGB: Telecommunications main grounding busbar.
- D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.05 ACTION SUBMITTALS

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

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, installation supervisor, and field inspector.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding 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. Result of the ground-resistance test, measured at the point of BCT connection.
 - b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.08 QUALITY CONTROL

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 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. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.02 CONDUCTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following provide products by one of the following:
 - 1. Harger Lightning & Grounding.
 - 2. Panduit Corp.
 - 3. TE Connectivity Ltd.
- B. Comply with UL 486A-486B.
- C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

D. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

E. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

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. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning & Grounding.
4. Panduit Corp.
5. TE Connectivity Ltd.

B. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

E. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

F. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

- 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. Chatsworth Products, Inc.
 - 2. Harger Lightning & Grounding.
 - 3. Panduit Corp.
- B. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.
 - 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 - 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- D. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
 - 1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 - 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 - 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 IDENTIFICATION

- A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the ac 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 the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.

3.03 APPLICATION

- A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support:
 - 1. Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 1/0 AWG.

3.05 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.
- B. 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.

3.06 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 1. Use crimping tool and the die specific to the connector.
 2. Pretwist the conductor.
 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.

3.07 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- B. Comply with IEEE C2 grounding requirements.
- C. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches extends above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- D. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect grounding conductors to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.08 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.09 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
 - 3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.
- E. Grounding system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 260533 Raceway and Boxes for Electrical Systems
- C. Section 260543 Underground Ducts and Raceways for Electrical

1.03 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Optical-fiber-cable pathways and fittings.
 - 3. Hooks.

1.04 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.05 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.06 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.
 - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. 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. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Alpha Wire.
 - 4. Anamet Electrical, Inc.
 - 5. Electri-Flex Company.
 - 6. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 7. Picoma Industries, Inc.
 - 8. Plasti-Bond.
 - 9. Republic Conduit.
 - 10. Southwire Company.
 - 11. Thomas & Betts Corporation; A Member of the ABB Group.
 - 12. Western Tube and Conduit Corporation.
 - 13. Wheatland Tube Company.
- C. EMT: Comply with ANSI C80.3 and UL 797.
- D. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.02 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for riser general-use installation unless otherwise indicated.
- B. 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. Alpha Wire.
 2. Carlon; a brand of Thomas & Betts Corporation.
 3. Dura-Line.
 4. Endot Industries Inc.
 5. IPEX USA LLC.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.03 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. 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. MonoSystems, Inc.
 2. Panduit Corp.
 3. Wiremold / Legrand.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION - Refer to Specification 260533

3.02 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications

Systems" for hangers and supports.

- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches of enclosures to which attached.
- L. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 4. Change from nonmetallic conduit and fittings to and fittings before rising above floor.
- M. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll

cutter or a guide to ensure cut is straight and perpendicular to the length.

- T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- U. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- V. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- W. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service pathway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- Y. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. 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.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
 2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet o.c.
 5. Provide a hook at each change in direction.
- AA. 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.
- BB. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- CC. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- DD. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- FF. Set metal floor boxes level and flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT - Refer to Specification 260543

3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES - Refer to Specification 260543

3.05 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS 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 Pathways".

3.06 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.07 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or 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

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SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems for communication raceways.
 - 2. Conduit and cable support devices.
 - 3. Support for conductors in vertical conduit.
 - 4. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.

1.04 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.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for communications hangers and support systems.
 - 1. Trapeze hangers. Include product data for components.

2. Steel slotted-channel systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 1. Suspended ceiling components.
 2. Ductwork, piping, fittings, and supports.
 3. Structural members to which hangers and supports will be attached.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Luminaires.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Projectors.
- B. Welding certificates.

1.06 QUALITY CONTROL

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 1. AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame Rating: Class 1.
 2. Self-extinguishing according to ASTM D635.

2.02 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 inches o.c. in at least one surface.
 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; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. Flex-Strut Inc.
 - e. Gripple Inc..
 - f. GS Metals Corp.
 - g. G-Strut.
 - h. Haydon Corporation.
 - i. Metal Ties Innovation.
 - j. MIRO Industries, Inc..
 - k. Thomas & Betts Corporation; A Member of the ABB Group.
 - l. Unistrut; Part of Atkore International.
 - m. Wesanco, Inc.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 4. Channel Width: Selected for applicable load criteria.
 5. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 7. Channel Dimensions: Selected for applicable load criteria.
- B. Conduit and Cable Support Devices: Steel clamps, hangers, 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 communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti, Inc.
 - 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.
 2. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel stainless steel for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
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: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101.
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as scheduled in NECA 1, where its Table 1 lists maximum spacings that are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 SUPPORT INSTALLATION

- A. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be

supported by openings through structure members, according to NFPA 70.

- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications 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: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Use 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 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

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SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Labels.
 - 2. Signs.
 - 3. Cable ties.
 - 4. Miscellaneous identification products.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. Labels.
 - 2. Cable ties.
 - 3. Miscellaneous identification products.
- B. Product Data Submittals: For each product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.
- C. Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
 - 3. Racks: Scaled drawings indicating location and proposed designation.
 - 4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.

- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels:
 - 1. Black letters on a white field.

2.03 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Brady Corporation.
 - b. Champion America.
 - c. Grafoplast Wire Markers.
 - d. HellermannTyton.
 - e. LEM Products Inc.
 - f. Marking Services Inc.
 - g. Panduit Corp.
 - h. Seton Identification Products; a Brady Corporation company.
 - i. emedco.
 - j. Approved equal.
- B. Self-Adhesive Labels: , thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors
 - b. 3-1/2 by 5 inches for equipment.

2.04 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services Inc.
4. Panduit Corp.
5. Approved equal..

B. 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 According to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.05 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.02 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 each 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 communications systems and connected items.
- G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- H. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a 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 inches high.

J. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.03 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 with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:

- a. Telecommunications.
- b. <Insert name>.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.
2. Colon.
3. Faceplate number.

E. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
2. Patch Panels: Label individual rows in each rack, starting at top and working down, with self-adhesive labels.
3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.

- c. Faceplate number.
- F. Backbone Cables: Label each cable with a vinyl-wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a vinyl-wraparound label indicating the following, in the order listed:
 - 1. Room number.
 - 2. Colon.
 - 3. Faceplate number.
- H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.
- I. Instructional Signs: Self-adhesive labels.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
- K. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label.
 - 2. Outdoor Equipment: .
 - 3. Equipment to Be Labeled:
 - a. Communications racks and cabinets.
 - b. Uninterruptible power supplies.
 - c. Power distribution components.

END OF SECTION

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SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment racks and cabinets.
- B. Related Requirements:
 - 1. Section 270526 "Grounding and Bonding for Communications Systems"
 - 2. Section 270536 "Cable Trays for Communications Systems" for cable trays and accessories.
 - 3. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - 4. Section 271500 "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.04 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered Communications Distribution Designer.

1.05 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 equipment racks and cabinets

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.06 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.07 QUALITY CONTROL

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.08 PREINSTALLATION MEETING.

- A. Mandatory preinstallation meeting is required for all Division 27 prior to starting Division 27 work.
- B. Conduct conference at Project site.
 1. Require representatives of each entity directly concerned with Division 27 to attend, including the following:
 - a. Contractor's superintendent.
 - b. Contractor's, RCDD
 - c. Contractor personnel performing testing.
 2. Review the following:
 - a. Division 27 Submittals.
 - b. Construction Sequencing to maintain continuity of service of the existing building telecommunications system.
 - c. MDF and IDF equipment room layouts.
 - d. Division 27 cabling installation methods:
 - 1) Routing.
 - 2) Raceway use.
 - 3) Separation from other utilities.
 - 4) Firestopping.
 - e. Outlet locations.
 - f. Client agency identification standards:
 - 1) Outlets.
 - 2) Cabling.
 - 3) Patch Panels.
 - 4) Data Racks

- g. Compliance with EIA/TIA standards.
- h. Testing procedures and documentation.

PART 2 - PRODUCTS

2.01 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.02 EQUIPMENT FRAMES

- 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. ADC.
 - 2. Belden Inc.
 - 3. Cooper B-Line.
 - 4. Emerson Network Power Connectivity Solutions.
 - 5. Hubbell Premise Wiring.
 - 6. Leviton Commercial Networks Division.
 - 7. Middle Atlantic Products, Inc.
 - 8. Ortronics, Inc.
 - 9. Panduit Corp.
 - 10. Simon Co. (The).
 - 11. Tyco Electronics Corporation; AMP Products.
- B. General Frame Requirements:
 - 1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- C. Floor-Mounted Racks: 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.
- D. 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.
 - 4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.03 POWER STRIPS

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. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
6. Close-coupled, direct plug-in line cord.
7. Rocker-type on-off switch, illuminated when in on position.
8. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground.
10. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.04 GROUNDING

A. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide with 9/32-inch holes spaced 1-1/8 inches apart.
3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

B. Comply with J-STD-607-A.

2.05 LABELING

- ### A.
- Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

- ### A.
- Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.
- ### B.
- Comply with requirements in Section 270528 "Pathways for Communications Systems" for materials and installation requirements for underground pathways.

3.02 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
 - 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - a. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 - 1) Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- E. Coordinate location of power raceways and receptacle with locations of communications equipment requiring electrical power to operate.

3.03 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
- B. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.04 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.05 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. Comply with J-STD-607-A.
- 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.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.06 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
- D. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. LAN: Local area network.
- D. RCDD: Registered communications distribution designer.
- E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- F. TGB: Telecommunications grounding bus bar.
- G. TMGB: Telecommunications main grounding bus bar.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. UL listed.
- B. RoHS compliant.
- C. Compliant with requirements of the Payment Card Industry Data Security Standard.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout of communications equipment spaces.
- C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

END OF SECTION

SECTION 271323 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Construction Contract", "Special Conditions", and "Division 1 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 SUMMARY

- A. Section Includes:
 - 1. Type OFNP optical fiber cable.
 - 2. Optical fiber cable hardware.

1.03 DEFINITIONS

- A. Conductive Cable: Cable containing non-current-carrying electrically-conductive members such as metallic strength members and metallic vapor barriers.
- B. Cross-Connect: A facility enabling termination of cable elements and their interconnection or cross-connection.
- C. Type OFCP: Conductive cable for use in plenums, ducts, and other spaces used for environmental air.
- D. Type OFCR: Conductive cable for use as riser in vertical shafts or from floor to floor.
- E. Type OFNP: Nonconductive cable for use in plenums, ducts, and other spaces used for environmental air.
- F. Type OFNR: Nonconductive cable for use as riser in vertical shafts or from floor to floor.
- G. Types OFC and OFCG: Conductive cable for general purpose use.
- H. Types OFN and OFNG: Nonconductive cable for general purpose use.

1.04 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.05 ACTION SUBMITTALS

- A. Product Data:

1. Type OFNR optical fiber cable.
2. Type OFNP optical fiber cable.
3. Optical fiber cable hardware.

B. Shop Drawings:

1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules, in software and format selected by Owner.
 - b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.
2. Cabling administration drawings and printouts.
3. Wiring diagrams showing typical schematic arrangement, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Cross-connects.
 - f. Patch panels.
 - g. Patch cords.
4. Cross-Connect and Patch-Panel Drawings: Detail mounting assemblies and show elevations and physical relationship between installed components.

C. Certificates: For each type of product.

D. Field Quality-Control Reports: Optical fiber cable testing plan.

1.06 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.

1.07 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For optical fiber cable, splices, and connectors.

1.08 DELIVERY, STORAGE, AND HANDLING

- 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 remainder of construction period.
- B. Test cables upon receipt at Project site.
1. Test optical fiber cable to determine continuity of strand end to end. Use optical fiber flashlight.
 2. Test optical fiber cable while on reels. Use optical time domain reflectometer to verify cable length and locate cable defects, splices, and connector, including loss value of each. Retain test data and include record in maintenance data.

PART 2 - PRODUCTS

2.01 TYPE OFNR OPTICAL FIBER 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.
2. Listing Criteria: UL CCN QAYK; including UL 1651.
3. General Characteristics:
 - a. Performance: TIA-568.3.
 - b. Inside Plant Mechanical Properties: ICEA S-83-596.
 - c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
 - d. Jacket:
 - 1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

2.02 TYPE OFNP OPTICAL FIBER CABLE

A. Type OFNP Optical Fiber Cable: This category covers jacketed optical fiber cable for use in vertical runs in plenums, ducts, or other spaces used for environmental air within buildings in accordance with Article 770 of NFPA 70 containing no electrically conductive materials.

B. 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 QAYK; including UL 1651.
3. General Characteristics:
 - a. Performance: TIA-568.3.
 - b. Inside Plant Mechanical Properties: ICEA S-83-596.
 - c. Inside-Outside Plant Mechanical Properties: ICEA S-104-696.
 - d. Jacket:
 - 1) Cable cordage jacket, fiber, unit, and group color in accordance with TIA-598.
 - 2) Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inch.

C. Type OFNP, Designation OM4, Multimode Optical Fiber Cable :

1. Manufacturers: Subject to compliance with requirements, provide products by the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CommScope, Inc.

- b. Corning Optical Communications; Corning Incorporated.
 - c. Hitachi Cable America Inc.
 - d. Mohawk; a division of Belden Networking, Inc.
 - e. Superior Essex Inc.; subsidiary of LS Corp.
 - f. TE Connectivity Ltd.
- 2. Source Limitations: Obtain products from single manufacturer.
- 3. Additional Characteristics:
 - a. Construction: TIA-492AAAD; 850 nm laser-optimized, 50 µm core diameter, 125 µm cladding diameter.
 - b. Minimum Overfilled Modal Bandwidth-Length Product: 3500 MHz-km at 850 nm wavelength; 500 MHz-km at 1300 nm wavelength.
 - c. Minimum Effective Modal Bandwidth-Length Product: 4700 MHz-km at 850 nm wavelength.
- 4. Options:
 - a. Configuration: 24-fiber, tight buffer, optical fiber cable.
 - b. Maximum Attenuation: at 850 nm wavelength; at 1300 nm wavelength.
 - c. Jacket Color: Aqua.

2.03 OPTICAL FIBER CABLE HARDWARE

- 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. American Technology Systems Industries, Inc.
 - 2. Belden Inc.
 - 3. Berk-Tek, a Leviton Company.
 - 4. CommScope, Inc.
 - 5. Corning Optical Communications; Corning Incorporated.
 - 6. Dynacom Corporation.
 - 7. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated.
 - 8. Molex Premise Networks.
 - 9. Optical Cable Corporation (OCC).
 - 10. Optical Connectivity Solutions Division <-- changed to Bel Fuse Inc.
 - 11. Siemon Co. (The).
- B. Performance Criteria:
 - 1. Fiber Optic Connector Intermateability Standard (FOCIS) specifications of TIA-604 series.
 - 2. TIA-568.3.
- C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
 - 1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- D. Connector Type: Type LC complying with TIA-604-10, connectors.
- E. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.

F. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to patch panel or faceplate.

2.04 SOURCE QUALITY CONTROL

A. Testing Administrator: Engage qualified testing agency to evaluate cables.

B. Factory Tests and Inspections:

1. Test and inspect multimode optical fiber cables, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.
2. Test and inspect pre-terminated optical fiber cable assemblies, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with TIA-526-14 and TIA-568.3 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

C. Nonconforming Work:

1. Cables that do not pass tests and inspections will be considered defective.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Coordinate backbone cabling with protectors and demarcation point provided by communications service provider.

3.02 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.

- C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.
- D. Backbone cabling system must comply with transmission standards in TIA-568.1.
- E. Telecommunications Pathways and Spaces: Comply with TIA-569.
- F. Wiring Methods:
 - 1. Not in Raceway: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
 - 2. In Raceway: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.
 - a. Install plenum cable in environmental airspaces, including plenum ceilings.
 - b. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."
 - 3. In Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- G. Optical Fiber Cabling Installation:
 - 1. Comply with TIA-568.1 and TIA-568.3.
 - 2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all cables; no cable may contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch and not more than 6 inch 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 cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
 - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps may not be used for heating.
 - 9. In communications equipment room, provide 10 ft long service loop on each end of cable.
 - 10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 - 11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- H. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Cable may not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- I. Installation of Cable Exposed under Raised Floors:
 - 1. Install plenum-rated cable only.

2. Install cabling after flooring system has been installed in raised floor areas.
3. Coil cable 6 ft long not less than 12 inch in diameter below each feed point.

J. Group connecting hardware for cables into separate logical fields.

3.03 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569, Annex A, "Firestopping."
- C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.04 GROUNDING

- A. Install grounding in accordance with BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.
- B. Comply with TIA-607 and NECA/BICSI-607.
- C. Locate grounding bus bar to minimize length of bonding conductors. Fasten to wall allowing at least 2 inch clearance behind grounding bus bar. Connect grounding bus bar with minimum 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to grounding bus bar, using not smaller than 6 AWG equipment grounding conductor.

3.05 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification must comply with TIA-606 for Class 4 level of administration including optional identification requirements of this standard.
- C. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for cable and asset management software.
- D. Cable Schedule: Install 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 electronic copy of final comprehensive schedules for Project.
- E. 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, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding

conductors.

F. Cable and Wire Identification:

1. Label each cable within 4 inch of each termination and tap, where it is accessible in 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 ft.
4. Label each unit and field within distribution racks and frames.
5. 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 different color for jacks and plugs of each service.

G. Labels must be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.06 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by the design professional.

B. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for qualified electrical testing laboratory certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:
 - a. Test instruments must meet or exceed applicable requirements in TIA-568.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction in accordance with TIA-526-14, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links must be less than 2.0 dB. Attenuation test results must be less than those calculated in accordance with equation in TIA-568.1.

C. Nonconforming Work:

1. Cables will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective cables and retest.

- D. Collect, assemble, and submit test and inspection reports.
 - 1. Data for each measurement must be documented.
 - 2. Data for field quality-control report submittals must be printed in summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from instrument to computer, saved as text files, and printed and submitted.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to supervise field tests and inspections.

END OF SECTION

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SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.01 STIPULATIONS

- A. The specifications sections "General Conditions of the Contract", "Special Conditions" and "Division 1 - General Requirements" for a part of this section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

1.02 RELATED DOCUMENTS

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

1.03 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. Cable connecting hardware, patch panels, and cross-connects.
 - 3. Telecommunications outlet/connectors.
 - 4. Cabling system identification products.
 - 5. Cable management system.
- B. Related Requirements:
 - 1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - 2. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.04 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet

cable terminates.

H. RCDD: Registered Communications Distribution Designer.

I. UTP: Unshielded twisted pair.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications 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.

1.06 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. Cabling administration drawings and printouts.
3. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Patch panels.
 - b. Patch cords.
4. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.07 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

1.08 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.09 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. Patch-Panel Units: One of each type.
 - 2. Device Plates: One of each type.

1.10 QUALITY CONTROL

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of UTP cable for open and short circuits. PART 2 - PRODUCTS

PART 2 - PRODUCTS

2.01 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. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 - 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 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. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the

horizontal cross-connect.

2.02 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.03 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.04 UTP 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. ADC.
 - 2. Belden Inc.
 - 3. Berk-Tek; a Nexans company.
 - 4. CommScope, Inc.
 - 5. Draka Cableteq USA.
 - 6. Genesis Cable Products; Honeywell International, Inc.
 - 7. Mohawk; a division of Belden Networking, Inc.
 - 8. Superior Essex Inc.
 - 9. SYSTIMAX Solutions; a CommScope, Inc. brand.
 - 10. 3M Communication Markets Division.
 - 11. Tyco Electronics Corporation; AMP Products.
 - 12. Or Engineer approved equal.
- B. Description: 100-ohm, four-pair UTP, binder groups covered with a blue thermoplastic jacket.
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. 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, complying with NFPA 262.

2.05 UTP CABLE HARDWARE

- 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. ADC.
 - 2. American Technology Systems Industries, Inc.
 - 3. Belden Inc.
 - 4. Dynacom Inc.
 - 5. Hubbell Premise Wiring.
 - 6. Leviton Commercial Networks Division.
 - 7. Molex Premise Networks; a division of Molex, Inc.
 - 8. Panduit Corp.
 - 9. Siemon Co. (The).
 - 10. Tyco Electronics Corporation; AMP Products.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 - 1. Number of Jacks per Field: One plus 25% spare capacity for each four-pair UTP cable indicated.
- E. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- F. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

2.06 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Provide number of ports as shown on the drawings, mounted in single or multigang faceplate.
 - 1. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

b. jacks shall match cable color.

2. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
3. Legend: Machine printed, in the field, using adhesive-tape label.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.07 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.08 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.09 CABLE MANAGEMENT SYSTEM

- 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. iTRACS Corporation, Inc.
 2. TelSoft Solutions.
 3. Or Engineer approved equal.
- B. Description: Computer-based cable management system, with integrated database capabilities.
- C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
- D. Information shall be presented in database view, schematic plans, or technical drawings.
 1. AutoCAD drawing software shall be used as drawing and schematic plans software.
- E. System shall interface with the following testing and recording devices:
 1. Direct upload tests from circuit testing instrument into the personal computer.
 2. Direct download circuit labeling into labeling printer.

2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.

- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.02 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
 - 3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.03 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - a. 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.
 - 1) Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.

- a) 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.
 - b. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - c. Cold-Weather Installation: Bring cable to room temperature before dereeling.
 - d. Heat lamps shall not be used for heating.
- 5. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
- 6. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
 - 1. Comply with TIA/EIA-568-B.2.
 - 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.
 - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
 - 1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or 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.
 - 3. 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.
 - 4. 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.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.04 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.05 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- 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.

3.06 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 1. Administration Class: 2.
 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
 - a. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For

fire-resistant plywood, do not paint over manufacturer's label.

- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration.
- D. Cable Schedule: Post in prominent location in each equipment room and wiring closet.
- E. 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. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

1. Cable and Wire Identification:

- F. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- G. 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.
- H. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
- I. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - 1. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - 2. Label each unit and field within distribution racks and frames.
 - 3. 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.
 - 4. 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.
- J. 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 TIA/EIA-606-A.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.07 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. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.08 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

3.09 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION

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