

SECTION 15010.- BASIC MECHANICAL REQUIREMENTS

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Work necessary to provide additions and supplements to existing plumbing and air conditioning systems, as specified in the various sections of this Division.

1.2.1.2 General administrative and procedural requirements for mechanical installations, and expands the requirements specified in Division 1. These requirements are:

1.2.1.2.1 Allowances.

1.2.1.2.2 Unit prices.

1.2.1.2.3 Definitions.

1.2.1.2.4 Contractor's qualifications.

1.2.1.2.5 Quality assurance.

1.2.1.2.6 Reference codes and standards.

1.2.1.2.7 Permits and inspections.

1.2.1.2.8 Equipment and materials.

1.2.1.2.9 Examination of premises.

1.2.1.2.10 Submittals.

1.2.1.2.11 Coordination drawings.

1.2.1.2.12 Record documents.

1.2.1.2.13 Contract Closeout.

1.2.1.2.14 Warranty.

1.2.1.2.15 Measurements.

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- 1.2.1.2.16 Operation prior to substantial completion.
- 1.2.1.2.17 Contractor operation prior to substantial completion.
- 1.2.1.2.18 Electrical work.
- 1.2.1.2.19 Painting.
- 1.2.1.2.20 Protection of equipment and work.
- 1.2.1.2.21 Rough-ins.
- 1.2.1.2.22 Mechanical installations.
- 1.2.1.2.23 Owner's Testing and Balancing.
- 1.2.1.2.24 Cutting and patching.
- 1.2.1.2.25 Maintaining construction area air pressure.
- 1.2.2 Related Sections:
 - 1.2.2.1 Division 15 Section "COMMON WORK RESULTS FOR PLUMBING" for plumbing demolition.
 - 1.2.2.2 Division 15 Section "COMMON WORK RESULTS FOR HVAC" for HVAC demolition.
 - 1.2.2.3 Division 15 Section "HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT" Single and multiple hangers, framing systems, and stands and supports.
 - 1.2.2.4 Division 15 Section "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT" Single and multiple hangers, framing systems, and stands and supports.
 - 1.2.2.5 Division 15 Section "IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT" Labels, stencils, and tags.
 - 1.2.2.6 Division 15 Section "IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT" Labels, stencils, and tags.
 - 1.2.2.7 Division 15 Section "PLUMBING INSULATION" Pipe insulation.
 - 1.2.2.8 Division 15 Section "HVAC INSULATION" Duct, equipment, and pipe insulation.
 - 1.2.2.9 Division 15 Section "GENERAL-DUTY VALVES FOR PLUMBING PIPING" Gate, globe, check, butterfly, & ball valves common to multiple systems.
 - 1.2.2.10 Division 15 Section "GENERAL-DUTY VALVES FOR HVAC PIPING" Gate, globe,

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check, butterfly, & ball valves common to multiple systems.

- 1.2.2.11 Division 15 Section "DOMESTIC WATER PIPING" Potable-water distribution within the building.
- 1.2.2.12 Division 15 Section "DOMESTIC WATER PIPING SPECIALTIES" Specialties, valves, and fittings for domestic water piping.
- 1.2.2.13 Division 15 Section "SANITARY WASTE AND VENT PIPING" Soil, waste, and vent piping within the building.
- 1.2.2.14 Division 15 Section "SANITARY WASTE PIPING SPECIALTIES" Floor drains and cleanouts.
- 1.2.2.15 Division 15 Section "HVAC PIPING" Hot-water, steam, and condensate piping.
- 1.2.2.16 Division 15 Section "COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES" Piping for non-medical air.
- 1.2.2.17 Division 15 Section "VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES" Piping for medical surgical vacuum, waste anesthetic gas,
- 1.2.2.18 Division 15 Section "GAS PIPING FOR HEALTHCARE FACILITIES" Piping for CO₂, NO₂, N₂ and O₂, and medical air.
- 1.2.2.19 Division 15 Section "METAL DUCTS" Rectangular and round, single- and double-wall ducts, including hangers and supports.
- 1.2.2.20 Division 15 Section "DUCT ACCESSORIES" Volume dampers, fire and smoke dampers, vanes, duct silencers, and hardware.
- 1.2.2.21 Division 15 Section "AIR TERMINAL UNITS" for variable air volume units.
- 1.2.2.22 Division 15 Section "DIFFUSERS, REGISTERS, AND GRILLES" Diffusers, registers, and grilles.
- 1.2.2.23 Division 15 Section "HVAC INSTRUMENTATION AND CONTROLS" for DDC equipment and devices.
- 1.2.2.24 Division 15 Section "SEQUENCE OF OPERATION" Control sequences for HVAC systems.
- 1.2.2.25 **FOR REFERENCE ONLY:** Division 15 Section "TESTING, ADJUSTING, AND BALANCING" Requirements for Owner's testing and balancing Agency and identification of required support under this Contract.

1.3 DEFINITIONS

- 1.3.1 Definitions apply to all Division 15 Specification Sections.

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- 1.3.1.1 Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.
- 1.3.1.2 Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.
- 1.3.1.3 Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.
- 1.3.1.4 Installer: The term "Installer" is defined as the entity (person or firm) engaged by the Contractor or its subcontractor or sub-subcontractor for performance of a particular unit of work at the project site, including installation, erection, application and similar required operations. Installers shall be skilled in the work they are to perform.
- 1.3.1.5 Specialist: The term "Specialist" means an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, and which maintains a regular force of workmen skilled in either (as applicable) manufacturing or fabricating items required by the contract, installing items required by the contract, or otherwise performing work required by the contract. Where the contract specification requires installation by a specialist, that term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform the work under the manufacturer's direct supervision.
- 1.3.1.6 Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- 1.3.1.7 Exposed Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- 1.3.1.8 Exposed Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- 1.3.1.9 Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- 1.3.1.10 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.

1.4 CONTRACTOR'S QUALIFICATIONS

- 1.4.1 An acceptable contractor for the work under this Division shall be a specialist in this field and have the personal experience, training and skill and the organization to provide a practical working system. If required, he shall be able to furnish acceptable evidence of having contracted for and installed not less than 3 systems of

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comparable size and type to this one, that have served their owners satisfactorily for not less than 3 years.

- 1.4.2 The foreman for this work shall have had experience in installing not less than 3 such systems and shall be approved before work is begun.
- 1.4.3 Work under this Division shall only be accomplished by entities licensed under provision of Section 2163, of the Rules and Regulations of the State of Louisiana Contractors License Law, R.S. 37:2150-2164.

1.5 QUALITY ASSURANCE

1.5.1 Manufacturer Qualifications:

- 1.5.1.1 Trade names, manufacturers and catalog numbers are mentioned herein and on the Drawings solely in order to establish a standard for the type, general design and quality of product required.
- 1.5.1.2 Other products similar in design, of equal quality and complying with the Drawings and Specifications will be considered after the contract is let only for those items with which the expression "or approved equal" is used.
- 1.5.1.3 Where two or more manufacturers or materials are named, the Contractor may submit any of those named, provided they conform to the Specification.
- 1.5.1.4 Identification in the project documents of any product by name, manufacturer or model number does not include either expressed or implied warranty of unqualified product acceptance.
- 1.5.1.5 All products must be capable of proper installation in the spaces provided, readily maintained and must satisfy other requirements contained in the contract documents.

1.5.2 Basis of Design:

- 1.5.2.1 If a single manufacturer and/or model number is indicated in the Contract Documents, it is for the purpose of identifying the product that is the basis of design, unless noted otherwise.

1.5.3 Motors:

- 1.5.3.1 Motors provided under this Division shall comply with NFPA 70 and shall be listed by a Nationally Recognized Testing Laboratory as defined in OSHA Regulation 19107.

1.6 REFERENCE CODES AND STANDARDS

- 1.6.1 Requirements set forth in reference codes and standards are minimum for equipment, material and work. In instances where capacities, size, etc., of equipment, devices or materials listed in the Contract Documents exceed these minimums, listed or shown capacities, etc. shall prevail.

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- 1.6.2 Comply with applicable laws, ordinances, codes and rules, with latest revisions, of the following governing agencies:
 - 1.6.2.1 International Building Code, 2006 Edition
 - 1.6.2.2 International Mechanical Code, 2006 Edition
 - 1.6.2.3 Sanitary Code of the State of Louisiana
 - 1.6.2.4 Fire Marshal of the State of Louisiana
 - 1.6.2.5 Louisiana Standard Plumbing Code, 2000 Edition.
- 1.6.3 Industry standards and specifications issued by the following organizations shall apply to materials and workmanship:
 - 1.6.3.1 AMCA Air Moving and Conditioning Association
 - 1.6.3.2 ASME American Society of Mechanical Engineers
 - 1.6.3.3 ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers
 - 1.6.3.4 ETL Engineering Testing Laboratory
 - 1.6.3.5 NEMA National Electrical Manufacturers' Association
 - 1.6.3.6 NFPA National Fire Protection Association
 - 1.6.3.7 SMACNA Sheet Metal and Air Conditioning Contractors' National Association
 - 1.6.3.8 UL Underwriters' Laboratories, Inc.
- 1.6.4 Local laws and codes take precedence over state laws and codes, which, in turn, take precedence over national codes and industry standards.
- 1.6.5 Comply with the rules and regulations of the "Safety Code for Mechanical Refrigeration", (ANSI/ASHRAE 15-2004).
- 1.7 **PERMITS, FEES, AND INSPECTIONS**
 - 1.7.1 **Permits and Fees:** Obtain and pay for all permits. Pay fees and all other payments required by utility regulatory bodies in connection with the Work. Pay for all inspections required under local codes with regard to the Work.
 - 1.7.2 **Certificates of Inspection:** Upon completion of the work, furnish certificates of inspection from all inspection or regulatory agencies having jurisdiction over work of Division 15.

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1.8 EQUIPMENT AND MATERIALS

- 1.8.1 Each item of equipment shall bear a name plate showing the manufacturer's name, trade name, model number, serial number, ratings and other information necessary to fully identify it. The plate shall be permanently mounted in a prominent location and shall not be concealed, insulated or painted.
- 1.8.2 The label of the approving agency, such as UL, AGA, ASME, ARI, AMCA, by which a standard has been established for the particular item, shall be in full view.
- 1.8.3 The equipment shall be essentially the standard product of a manufacturer regularly engaged in the production of such equipment and shall be the manufacturer's latest design.
- 1.8.4 Deliver equipment and materials to the site and store in original containers, suitably sheltered from physical damage and the elements, but readily accessible for inspection. Equipment damaged in shipment will not be acceptable.

1.9 EXAMINATION OF PREMISES

- 1.9.1 Visit the site of the proposed work before bidding. Inspect the site and become familiar with the difficulties and restrictions attending the execution of the contract.
- 1.9.2 No additional compensation will be allowed for failure to be informed of site conditions.

1.10 SUBMITTALS

- 1.10.1 General:
 - 1.10.1.1 Submit for review shop drawings, product data and samples. Comply with requirements of Division 1 Section "Submittals".
 - 1.10.1.2 Minimum number of copies shall be four (4).
 - 1.10.1.3 Mark each individual item with pertinent specification section and paragraph number. Submittal will be rejected if specification and paragraph number under which it is being submitted is not identified.
 - 1.10.1.4 Deviations:
 - 1.10.1.4.1 If the submittal deviates from the requirements of the Contract Documents, the deviation shall be identified in writing on the first page of the submittal.
 - 1.10.1.4.2 Identify where within the Contract Documents the deviation occurs.
 - 1.10.1.4.3 The deviation shall only be considered acceptable if the identified deviation has been initialed by the Engineer.

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- 1.10.1.4.4 Any deviation not initialed may be assumed to be rejected.
- 1.10.1.4.5 All coordination required due to the deviation, such as space allocation, changes to electrical service, or any other required changes shall be born as Work of Division 15 but accomplished by Installers skilled in the Work being performed.
- 1.10.1.4.6 No costs incurred by the approved deviation shall be born by the Owner.
- 1.10.1.4.7 Approval of deviations does not relieve the Contractor of responsibility for compliance with all other aspects of the Contract Documents.
- 1.10.1.5 Review of shop drawings and submittals does not relieve the Contractor of responsibility for compliance with the specific requirements of the Contract Documents, or for fitting the equipment in the space allotted, with proper space for connection of piping or ductwork and for servicing or for coordination of the work with work of other trades.
- 1.10.1.6 Review is for general conformance with the design concept of the project and general compliance with the information given in the project documents.
- 1.10.1.7 Responsibility for confirming and correlating all quantities and dimensions, selecting fabrication processes and establishing techniques of construction resides with Contractor.
- 1.10.1.8 Review subcontractors' submittals and shop drawings and indicate by rubber stamp or letter that they have been reviewed and approved before forwarding them.
- 1.10.1.9 Submittals and Drawings will be returned after review indicating whether or not exceptions are taken and the required procedure to be followed thereafter.
- 1.10.1.10 Revised and acceptable submittals and shop drawings are required before construction is begun.
- 1.10.1.11 Include dimensional data and weights of equipment.
- 1.10.1.12 Include motor manufacturers' names.
- 1.10.1.13 In general, the Architect and/or his consultants will review each submittal as indicated above.
- 1.10.1.14 If submittal does not comply with the Contract Documents as indicated by the submittal being marked "REJECTED" and "RESUBMIT", or other similar markings, be responsible for any additional costs the Owner incurs due to review of follow-on submittals.
- 1.10.2 Shop Drawings:
- 1.10.2.1 Shop drawings shall consist of plans, sections, elevations and details to scale (no smaller than 1/4" per foot), with dimensions clearly showing the installation.

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- 1.10.2.2 Direct copies of small scale project drawings issued to the Contractor are not acceptable.
- 1.10.2.3 Drawings shall take into account equipment furnished under other Divisions and shall show space allotted for it. Include construction details and materials.
- 1.10.2.4 As a minimum, submit shop drawings covering equipment rooms, equipment foundations, equipment supports, ductwork, field-fabricated equipment, piping or any other drawings specifically called for in this and other Sections.
- 1.10.2.5 Include the following:
 - 1.10.2.5.1 Controls and instrumentation, including complete electrical interlock diagrams.
 - 1.10.2.5.2 Built-up equipment.
 - 1.10.2.5.3 Equipment rooms (any room in which there is Division 15 equipment).
 - 1.10.2.5.4 Equipment housekeeping pads, and vibration isolation.
 - 1.10.2.5.5 Field-fabricated hangers, supports, guides and anchors.
 - 1.10.2.5.6 Piping in Equipment Rooms.
- 1.10.2.6 The drawings show existing construction components and systems as on record by the Owner.
- 1.10.2.7 As part of the shop drawing process, field verify location and size of structural members, location of partitions, and existing systems shown.
- 1.10.2.8 If field measurements differ from the information on the drawings which causes a conflict in the Work, promptly consult the Architect for resolution.
- 1.10.2.9 The Owner shall not be responsible for any delays in construction due to the Contractor failing to field verify information shown on the drawings as existing.
- 1.10.3 Product Data:
 - 1.10.3.1 Product data is defined as manufacturers' printed literature specifically marked to indicate size and model and accompanied by rating sheets listing values showing that equipment meets scheduled or specified values.
 - 1.10.3.2 Properly coded stamp "No exception taken" or similar marking on submittal is required before ordering equipment unless otherwise noted.
 - 1.10.3.3 Submit items identified in the individual Sections.

1.11 COORDINATION DRAWINGS

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- 1.11.1 Prepare coordination drawings in accordance with Division 1 Section "COORDINATION DRAWINGS" and as follows.
 - 1.11.1.1 Drawings shall be to a minimum scale of 1/4" = 1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other building systems, installations, and components.
 - 1.11.1.2 Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the work.
 - 1.11.1.3 Indicate the proposed locations of piping, ductwork, equipment, and materials and include vertical measurement from floor to bottom of piping, ductwork, and elevated equipment.
 - 1.11.1.4 Piping drawings shall include access panel locations, valves, sleeves, location of supports, etc.
 - 1.11.1.5 Ductwork drawings shall include access panel locations (in duct and building construction to obtain entry to service and maintain duct mounted equipment), vanes, scoops, splitters, dampers, grilles, diffusers, coils, etc.
 - 1.11.1.6 Vertical measurement shall be indicated at all changes in direction of piping and ductwork.
 - 1.11.1.7 Measurement shall be made to the outside surface of exterior insulated ducting and piping.
 - 1.11.1.8 Measurements shall include clearances for installing and maintaining insulation; servicing and maintaining equipment; space for equipment disassembly for periodic maintenance; and showing areas for tube, filter, and coil removal.
 - 1.11.1.9 Provide details of connections and supports, exterior wall and foundation penetrations, sizes and locations of concrete housekeeping pads, and indicate space for valve stem movement.
 - 1.11.1.10 Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - 1.11.1.11 Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
 - 1.11.1.12 Include location of sleeves in floors, walls, and ceilings.
 - 1.11.1.13 Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication system components, sprinklers, smoke detectors, and other ceiling mounted items.

1.12 RECORD DOCUMENTS

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- 1.12.1 Prepare record documents in accordance with the requirements in Division 1 Section "Contract Closeout".
- 1.12.2 As a minimum, record documents shall show ductwork; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair; piping systems with valves and control devices located and numbered according to tags; concealed unions and items requiring maintenance such as traps, strainers, expansion compensators, expansion and compression tanks.
- 1.12.3 Locate all access panels installed to maintain mechanical equipment.
- 1.12.4 Reference prominent building lines when showing dimensions of equipment, pipe, ducting, and access panels.
- 1.12.5 Identify installations different from the original plans due to product substitutions, Contract Modifications, and actual equipment and material installed.
- 1.13 **CONTRACT CLOSEOUT**
- 1.13.1 Mark and otherwise correct a set of reproducible drawings to reflect the final location of all work installed under Division 15, to serve as record documents, in accordance with Division 1 Section "Contract Closeout".
- 1.13.2 Locate cleanouts, valves, traps, manual and automatic dampers, fire and smoke dampers, control sensing elements in ducts, and other concealed items requiring adjustment or maintenance.
- 1.13.3 Supplement with additional sketches on tracing paper for clarification, if necessary.
- 1.13.4 Certify in writing that record drawings have been checked and are accurate.
- 1.13.5 Submittal of these documents is a prerequisite for certification of substantial completion.
- 1.13.6 Contractor may obtain a set of reproducible drawings from the Architect and shall pay for them.
- 1.13.7 Conform to other requirements included in Division 1 Section, "Contract Closeout".
- 1.14 **WARRANTY**
- 1.14.1 Refer to applicable paragraph under GENERAL CONDITIONS.
- 1.14.2 Warrant all materials and workmanship for a period of one year.
- 1.14.3 Repair or replace promptly defects due to faulty materials, methods of installation or workmanship, with the least inconvenience and without expense to the Owner and at time designated by the Architect within the one-year period.

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- 1.14.4 Provide additional specific performance or extended time warranties called for in the individual Sections under this Division.
- 1.14.5 The warranty period for mechanical work shall commence on the date certified by the architect or engineer that the contract is substantially complete in accordance with the plans and specifications, or upon beneficial use by the Owner, whichever occurs first.
- 1.14.6 When beneficial use is for only a portion of the work, the warranty shall commence only on that portion of the work.

1.15 MEASUREMENTS

- 1.15.1 Because of the small scale of the Drawings, it is not possible to indicate all offsets and fittings or to locate every accessory.
- 1.15.2 Study carefully the sizes and locations of structural members, wall and partition locations, attic spaces, ceiling furring, chase spaces and room dimensions and take actual measurements on the job.
- 1.15.3 Locate ductwork, piping, equipment and accessories, with sufficient space for installing, insulating and servicing.
- 1.15.4 Contractor is responsible for accuracy of his measurements and shall not order materials or perform work without verification.
- 1.15.5 No extra compensation will be allowed because field measurements vary from the dimensions on the Drawings.
- 1.15.6 If field measurements show that equipment, piping or ductwork can not be fitted, the Architect shall be consulted.
- 1.15.7 All equipment, apparatus and materials must fit into the available, designated spaces, with proper clearances for maintenance, service and repair.

1.16 OPERATION PRIOR TO SUBSTANTIAL COMPLETION

- 1.16.1 Owner shall have the right to operate systems and equipment prior to substantial completion, as soon as tested and operational, provided all safety devices have been installed.
- 1.16.2 Agreement between Owner and Contractor relative to time and hours of operation and responsibility for start up and shutdown is required.
- 1.16.3 Do not permit operation which may damage equipment or cause damage to the building or to the work of other contractors.
- 1.16.4 Air filters shall be in place on air conditioning units and strainers must be in place in all piping systems prior to operation.

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1.17 CONTRACTOR OPERATION PRIOR TO SUBSTANTIAL COMPLETION

- 1.17.1 Obtain written authorization from the Owner for Contractor's use of equipment.
- 1.17.2 If equipment is allowed to be used during construction period, all start-up requirements for the equipment shall be adhered to prior to operation including start-up procedures, required equipment check-out by factory authorized representatives, required equipment inspection reports, and commissioning as required in the individual Sections.
- 1.17.3 A copy of operating and maintenance manuals shall be kept on-site while equipment is in operation. These manuals shall be made available to Owner's maintenance crews if Contractor is off-site and equipment is still in operation.
- 1.17.4 In addition, no sooner than seven days prior to Substantial Completion being requested, original equipment check-out by factory authorized representative, required equipment inspection reports, and commissioning shall be completed a second time.
- 1.17.5 Equipment or components found not in compliance with the Contract Documents shall be replaced without cost to the Owner.
- 1.17.6 Submit by letter to the Owner the date in which each piece of equipment is put into operation.
- 1.17.7 Maintain duct cleanliness during air handling equipment use by installing minimum 30% filter material over all return and exhaust openings.
- 1.17.8 If duct cleanliness is found by the Architect to be unacceptable, duct shall be cleaned with alcohol impregnated pad and pad changed as it loads with dirt. Provide additional access panels within the ductwork allowing cleaning to be completed. Added access panels required for this remedial cleaning shall be provided at no cost to the Owner.

1.18 ELECTRICAL WORK

- 1.18.1 General:
 - 1.18.1.1 Electrical service shall be as indicated on the Drawings.
 - 1.18.1.2 All power wiring and all circuit breakers, starters, disconnect switches, pilot lights, hand-off-automatic (H-O-A) switches, pushbutton stations, except such items which are provided as part of "packaged" mechanical equipment or specifically noted herein, shall be furnished, set in operating position, and electrically connected as work of DIVISION 16, ELECTRICAL.
 - 1.18.1.3 Should the Contractor desire to use equipment requiring larger motors or electrical characteristics differing from those shown, it is the responsibility of work requirements under Division 15 to inform other affected parties of the proposed changes to permit them to supply proper wiring, disconnects and starters. Additional

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costs incurred to work of other Divisions caused by such changes shall be borne as work of Division 15.

- 1.18.1.4 Coordination to establish areas of possible change between Division 15 work and work of another Division shall occur prior to equipment delivery from the manufacturer.
- 1.18.2 Motor Starters:
 - 1.18.2.1 Starters furnished with mechanical equipment covered by this section shall conform to the requirements of Division 16.
 - 1.18.2.2 Provide motor overload protection requirements for sizing overload protection device for motor starters furnished under Division 16.
- 1.18.3 Conduit and Wiring:
 - 1.18.3.1 As work of Division 15, all interlock conduit and wiring and control conduit and wiring shall be provided, and all control elements shall be set in position and connected.
 - 1.18.3.2 Electrical wiring for firestats or smoke detectors which interrupt line voltage power circuits to motors and for wall-mounted thermostats which interrupts line voltage power circuits to motors and interlock from smoke detectors for the shutdown of motors shall be work of Division 15.
 - 1.18.3.3 Provide control transformers and additional relays required for interface with the electrical system for all equipment controls needing 24V power.
 - 1.18.3.4 Unless indicated otherwise, power wiring and conduit for all devices shall be work of Division 16.
- 1.18.4 Motors: See Division 15 Section "Common Motor Requirements for HVAC Equipment."
 - 1.18.4.1 Unless otherwise specified herein, all motors shall be of the squirrel-cage, premium-efficiency type, constant speed, general purpose for operation on phase and voltage shown in the Contract Documents.
 - 1.18.4.2 Motors shall be guaranteed to operate continuously at full load at 10 percent voltage variation above or below specified voltage and with temperature rise not to exceed 40 degrees C in any part.
 - 1.18.4.3 Unless noted or specified otherwise, motors not exposed to the weather shall have open-type enclosures; motors exposed to the weather shall be of the enclosed type.
 - 1.18.4.4 Motors shall have drip-proof and leak-proof sleeve bearings or pre-lubricated ball bearings.

1.19 PAINTING

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- 1.19.1 Painting shall be done under Division 09 Sections "PAINTING", "INTERIOR PAINTING", "EXTERIOR PAINTING", "HIGH-PERFORMANCE-COATINGS", and/or "HIGH-TEMPERATURE-RESISTANT COATINGS"; except for touch-up of factory finishes on equipment located inside and outside.
- 1.19.2 For touch-up of factory finishes, obtain matched color coatings from the manufacturer and apply as directed. Prime coating of certain equipment is specified under individual equipment specification.
- 1.19.3 If corrosion is found during inspection on the surface of any equipment or other painted Work installed under Division 15, clean, prime, and paint in accordance with requirements of the aforementioned Division 09 Sections.
- 2 PART 2 - PRODUCTS – Not applicable to this Section.
- 3 PART 3 - EXECUTION
- 3.1 PROTECTION OF EQUIPMENT AND WORK
- 3.1.1 Continuously maintain adequate protection of stored materials and installed work.
- 3.1.2 Tightly cover fixtures and equipment, with sheet polyethylene or waterproof tarpaulin as protection against dirt, rust and moisture.
- 3.1.3 Provide heat to equipment being stored to prevent condensation.
- 3.1.4 Do not store materials and equipment outside, directly on the ground, or in areas where it may be subject to physical injury from vehicular traffic or construction machinery.
- 3.1.5 Ductwork, piping and equipment installed under this Division shall not be used by other trades as supports for scaffolds or personnel.
- 3.1.6 Do not deliver controls or other delicate equipment to the job site unless they can be placed in protected areas.
- 3.1.7 At work completion, clean equipment, fixtures, exposed ductwork and piping, including hangers and supports to the Architect's satisfaction.
- 3.2 ROUGH-IN
- 3.2.1 Verify the final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.
- 3.3 MECHANICAL INSTALLATIONS
- 3.3.1 Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment with other building components.

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- 3.3.2 Verify all dimensions by field measurements.
- 3.3.3 Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.
- 3.3.4 Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
- 3.3.5 Sequence and coordinate installation of large pieces of equipment prior to closing in the building.
- 3.3.6 Install systems, materials, and equipment to conform with approved submittal data and coordination drawings, to greatest extent possible.
- 3.3.7 Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form.
- 3.3.8 Where coordination requirements conflict with individual system requirements, refer conflict to the Architect with a suggested resolution.
- 3.3.9 Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building components.
- 3.3.10 Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum ceiling heights possible.
- 3.3.11 Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components without requiring the removal of permanent construction or disabling the function of a required fire-resistance-rated assembly.
- 3.3.12 As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- 3.3.13 Extend grease fittings to an accessible location external to the piece of equipment.
- 3.3.14 Install access panel or doors where equipment is concealed behind finished surfaces. See Division 8 Section "ACCESS DOORS AND FRAMES" and Division 15 Sections "COMMON WORK RESULTS FOR PLUMBING" and "COMMON WORK RESULTS FOR HVAC".
- 3.3.15 System Installations:
 - 3.3.15.1 Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 3.3.15.2 In general, ductwork shall take precedence over piping.
 - 3.3.15.3 Set system elevations to minimize offsets where systems cross.

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- 3.3.15.4 Make full use of all three dimensions and stack ductwork, equipment, and accessories vertically as required.
- 3.3.15.5 Remove and relocate, without additional compensation, any item that is installed and is later found to encroach on space assigned to another use.
- 3.4 **OWNER'S TESTING AND BALANCING**
 - 3.4.1 **General:** Testing and balancing of the air handling unit AHU-4, all VAV boxes installed under this Contract, and all exhaust fans installed under this Contract or existing exhaust systems that are modified by changing capacity, will be provided by the Owner under separate contract with a test and balancing Agency of his choosing.
 - 3.4.1.1 Review Division 15 Section 15950 "Testing, Adjusting, and Balancing" to establish the level of work effort required to assist the Owner's test and balancing Agency.
 - 3.4.2 Coordinate work efforts between the Owner's selected agency and work of this Contract.
 - 3.4.3 Provide appropriate technicians for meetings identified in Division 15 Section "Testing, Balancing, and Adjusting."
 - 3.4.4 Provide the required technical personnel to aid the Owner's test and balancing agency with the test and balance work.
 - 3.4.4.1 Make sheave changes or adjustments as necessary to provide the required air flow rates from fans as determined by the Owner's test and balancing Agency.
 - 3.4.4.2 Provide the control technician involved in most of the Controls installation and/or programming on-site at the time of test and balancing to assist in set point changes, sensor readings, and to make minor changes in the programming.
 - 3.4.5 Provide a copy of all sheet metal and hydronic piping shop drawings to the Owner's test and balancing Agency for his use.
 - 3.5 **CUTTING AND PATCHING**
 - 3.5.1 **General:** Perform cutting and patching in accordance with Division 1 requirements.
 - 3.5.2 Engage experienced installers in cutting and patching this work.
 - 3.5.3 Installers' qualifications refer to the materials and methods required for the surface

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and building components being patched.

- 3.5.4 Protect adjacent installations during all cutting and patching operations.
- 3.5.5 Perform cutting, fitting, and patching for mechanical equipment and material installation.
- 3.5.6 Uncover work to provide for installation of ill-timed work.
- 3.5.7 Remove and replace defective mechanical work and work not conforming to requirements of the Contract Documents.
- 3.5.8 Install equipment and materials in existing structures.
- 3.5.9 Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers.
- 3.5.10 Upon written instructions from the Architect, uncover and restore work to provide for Architect observation of concealed work covered prior to inspection.
- 3.5.11 Uncovering and restoring work required to be observed by the Architect prior to covering as identified in the Contract Documents will be at no cost to the Owner.
- 3.5.12 Cut, remove, and legally dispose of selected mechanical equipment, components, and materials including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items as identified in the Contract Documents.
- 3.5.13 Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
- 3.5.14 Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers.

3.6 CONSTRUCTION AREA PRESSURE MAINTENANCE

- 3.6.1 **General:** Maintain construction area pressure lower than the surrounding building by providing temporary exhaust fans, ductwork, sensors, and controllers. See Division 15 Section "Common Work Results for HVAC".

END OF SECTION 15010

SECTION 15052 - COMMON WORK RESULTS FOR PLUMBING

1 PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following:

- 1.2.1.1 Escutcheons and sleeves.

- 1.2.1.2 Plumbing demolition.

1.3 SUBMITTALS

- 1.3.1 Product Data: For escutcheons.

1.4 COORDINATION

- 1.4.1 Coordinate plumbing demolition with Work of other Sections.

- 1.4.2 For work on existing systems, notify Architect and Owner a minimum of seven business days prior to scheduled start of work and obtain Owner's permission to start work.

2 PART 2 – PRODUCTS

2.1 SLEEVES

- 2.1.1 Galvanized-Steel-Sheet Sleeve: 0.0239-inch minimum thickness, round tube closed with welded longitudinal joint.

2.2 ESCUTCHEONS

- 2.2.1 Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

- 2.2.2 One-Piece, Cast-Brass Type: With set screw and polished chrome-plated finish.

- 2.2.3 One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

- 2.2.4 Split-Plate, Stamped-Steel Type: With exposed-rivet hinge, spring clips, and chrome-plated finish.

- 2.2.5 Split-Casting, Cast-Brass Type: With concealed hinge and set screw; polished

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chrome-plated finish.

3 PART 3 – EXECUTION

3.1 PLUMBING DEMOLITION

- 3.1.1 Refer to Division 1 Sections "Cutting and Patching" for general demolition requirements and procedures.
- 3.1.2 Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
- 3.1.2.1 Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
- 3.1.3 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.
- 3.1.4 Carefully disconnect and remove plumbing fixtures that are indicated to be salvaged or relocated and re-used.
- 3.1.5 Existing sanitary waste and vent piping over the existing operating rooms is copper with soldered joints.

3.2 ESCUTCHEONS AND SLEEVES

- 3.2.1 Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 3.2.1.1 New Piping:
 - 3.2.1.1.1 Bare Piping at Partition Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - 3.2.1.1.2 Insulated Piping: One-piece, stamped-steel type with spring clips.
 - 3.2.1.2 Existing Piping: Use the following:
 - 3.2.1.2.1 Bare Piping at Partition Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
 - 3.2.1.2.2 Insulated Piping: Split-plate, stamped-steel type with exposed-rivet hinge and spring clips.
- 3.2.2 Install sleeves for pipes passing through gypsum-board partitions.
 - 3.2.2.1 Cut sleeves to length for mounting flush with both surfaces.
 - 3.2.2.2 Install sleeves that are large enough to provide 1/4-inch annular clear space

SECTION 15052 - COMMON WORK RESULTS FOR PLUMBING

between sleeve and pipe or pipe insulation.

- 3.2.2.3 Seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

END OF SECTION 15052

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SECTION 15053 - COMMON WORK RESULTS FOR HVAC

1 PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following:
- 1.2.1.1 Dielectric fittings.
 - 1.2.1.2 Mechanical sleeve seals.
 - 1.2.1.3 Sleeves.
 - 1.2.1.4 Escutcheons.
 - 1.2.1.5 HVAC demolition.
 - 1.2.1.6 Negative pressure maintenance requirements within the Construction space.

1.3 DEFINITIONS

- 1.3.1 The following are industry abbreviations for rubber materials:
- 1.3.1.1 EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 1.3.1.2 NBR: Acrylonitrile-butadiene rubber.

1.4 ACTION SUBMITTALS

- 1.4.1 Product Data: For the following:
- 1.4.1.1 Dielectric fittings.
 - 1.4.1.2 Mechanical sleeve seals.
 - 1.4.1.3 Escutcheons.

2 PART 2 – PRODUCTS

2.1 MANUFACTURERS

- 2.1.1 In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

SECTION 15053 - COMMON WORK RESULTS FOR HVAC

2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 DIELECTRIC FITTINGS

2.2.1 Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

2.2.2 Insulating Material: Suitable for system fluid, pressure, and temperature.

2.2.3 Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.

2.2.3.1 Manufacturers:

2.2.3.1.1 Epco Sales, Inc.

2.2.3.1.2 Hart Industries, International, Inc.

2.2.3.1.3 Watts Industries, Inc.; Water Products Div.

2.2.3.1.4 Zurn Industries, Inc.; Wilkins Div.

2.2.4 Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

2.2.4.1 Manufacturers:

2.2.4.1.1 Calpico, Inc.

2.2.4.1.2 Lochinvar Corp.

2.3 MECHANICAL SLEEVE SEALS

2.3.1 Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

2.3.1.1 Manufacturers:

2.3.1.1.1 Advance Products & Systems, Inc.

2.3.1.1.2 Calpico, Inc.

2.3.1.1.3 Metraflex Co.

2.3.1.1.4 Pipeline Seal and Insulator, Inc.

2.3.1.2 Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include

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type and number required for pipe material and size of pipe.

- 2.3.1.3 Pressure Plates: Stainless steel. Include two for each sealing element.
- 2.3.1.4 Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 SLEEVES

- 2.4.1 Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- 2.4.2 Galvanized-Steel-Sheet Sleeve: 0,0239-inch minimum thickness, round tube closed with welded longitudinal joint.

2.5 ESCUTCHEONS

- 2.5.1 Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- 2.5.2 One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- 2.5.3 One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

3 PART 3 – EXECUTION

3.1 INDOOR WORK ENVIRONMENT PREPARATION

- 3.1.1 Prior to beginning demolition work, provide material, equipment, and labor to install a temporary exhaust system to automatically maintain the indoor environmental pressure to 0.05 inches of water column below the surrounding occupied space pressure.
- 3.1.2 Obtain the services of a testing and balancing agency to determine the exact exhaust air flow rate required to maintain the specified pressure differential.
 - 3.1.2.1 Preliminary estimates show the required exhaust air flow rate to maintain the differential pressure set point is between 1,000 and 3,000 CFM.
 - 3.1.2.2 Since exhaust air flow rate required is dependent on existing construction as well as new construction, increase or decrease exhaust flow rate as conditions dictate to achieve and maintain the specified differential pressure set point.
- 3.1.3 Provide exhaust system comprising of
 - 3.1.3.1 Exhaust fan(s).

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- 3.1.3.2 Temporary flexible ductwork.
- 3.1.3.3 Temporary duct hangers.
- 3.1.3.4 Connections to exterior wall.
- 3.1.3.5 Louvers at exterior wall penetrations to mitigate water intrusion.
- 3.1.3.6 Controls.
- 3.1.3.7 Temporary electrical power to include disconnects.
- 3.1.3.8 Miscellaneous other items required for temporary system to maintain specified pressure differential.
- 3.1.4 Controls shall consist of:
 - 3.1.4.1 Differential pressure sensor capable of accurately maintaining the specified pressure differential without undue false alarms.
 - 3.1.4.2 Visual only negative pressure non-electric indicator consisting of clear tube and clear hemispheres with red ball, length as necessary to cross wall. Basis-of-Design is Airflow Direction Inc, Model ADI-69-V-N. Install unit in accordance with manufacturer's instructions across temporary partitions separating construction and occupied portions of the building.
 - 3.1.4.3 A local alarm at the Nurses Station that registers if the specified differential pressure falls below set point for longer than 1 minute (adjustable).
 - 3.1.4.4 A remote alarm connected to the Hospital's existing building automation system (TRANE Tracer Summit System). When in alarm, the signal shall register on the Hospital's central building automation system.
- 3.1.5 Service and maintain temporary exhaust system as necessary throughout the period of Construction.
- 3.1.6 Remove all temporary exhaust system components prior to calling for Substantial Completion.
- 3.2 HVAC DEMOLITION
 - 3.2.1 Refer to Division 1 Sections for general demolition requirements and procedures.
 - 3.2.2 Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 3.2.2.1 Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material. Provide valves at capped ends as indicated.

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- 3.2.2.2 Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material. Install insulation over cap and repair damaged insulation as necessary.
- 3.2.2.3 Equipment to Be Removed: Disconnect and cap services and remove equipment.
- 3.2.2.4 Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
- 3.2.3 If pipe, insulation, or equipment to remain, or removed and re-installed, is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- 3.2.4 Sterilizer: Disconnect steam, condensate, and drain piping from sterilizer. Note fittings, valves, and steam traps located in piping, including type, size, and capacity. Provide new fittings, valves, traps, and other accessories as necessary for re-installing the sterilizer at the new location. See addition requirements in Division 15 Section "HVAC Piping."
- 3.2.5 Baseboard Heater: Isolate and disconnect baseboard heater from heating hot water piping. Install isolation valves as necessary on existing $\frac{3}{4}$ " branch heating hot water connections to heaters to isolate heating hot water main piping from baseboard heaters. Carefully remove heater and mounting brackets. Protect heater from damage, to include damaging painted surface. Store heater within the area of construction off the floor and away from on-going construction.
- 3.3 ESCUTCHEONS AND SLEEVES
 - 3.3.1 Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 3.3.1.1 New Piping:
 - 3.3.1.1.1 Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - 3.3.1.1.2 Insulated Piping: One-piece, stamped-steel type with set screws or spring clips.
 - 3.3.1.2 Existing Piping: Use the following:
 - 3.3.1.2.1 Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge and spring clips.
 - 3.3.2 Sleeves are not required for core-drilled holes.
 - 3.3.3 Install sleeves for pipes passing through gypsum-board partitions and concrete roof slabs.
 - 3.3.3.1 Cut sleeves to length for mounting flush with both surfaces.

SECTION 15053 - COMMON WORK RESULTS FOR HVAC

- 3.3.3.1.1 Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
- 3.3.3.2 Install sleeves in new partitions as they are constructed.
- 3.3.3.3 Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - 3.3.3.3.1 Steel Pipe Sleeves: For pipes penetrating concrete floors.
 - 3.3.3.3.2 Steel Sheet Sleeves: For pipes penetrating gypsum-board partitions.
- 3.3.3.4 Seal annular space between pipe sleeve and pipe or pipe insulation, using mechanical sleeve seal that is UL listed for the fire partitioning between floors. Where mechanical sleeve seal is not available for a particular fire separation rating, seal penetration with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- 3.3.3.5 Seal annular space between sheet sleeve and pipe or pipe insulation, using joint sealants in compliance with Division 7 requirements.

END OF SECTION 15053

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1 PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following hangers and supports for plumbing system piping and equipment:

1.2.1.1 Steel pipe hangers and supports.

1.2.1.2 Trapeze pipe hangers.

1.2.1.3 Fastener systems.

1.2.1.4 Equipment supports.

1.2.2 Related Sections include the following:

1.2.2.1 Division 5 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.2.2.2 Division 13 Section "Wet-Pipe Sprinkler Systems" for pipe hangers for fire-suppression piping.

1.3 DEFINITIONS

1.3.1 MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

1.3.2 Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

1.4.1 Product Data: For the following:

1.4.1.1 Steel pipe hangers and supports.

1.4.1.2 Powder-actuated fastener systems.

1.4.2 Shop Drawings: Show fabrication and installation details and include calculations for the following:

1.4.2.1 Trapeze pipe hangers. Include Product Data for components.

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

1.4.2.2 Equipment supports.

1.4.3 Welding certificates.

1.5 QUALITY ASSURANCE

1.5.1 Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

2 PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

2.1.1 Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

2.1.2 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.1.2.1 B-Line Systems, Inc.; a division of Cooper Industries.

2.1.2.2 Carpenter & Paterson, Inc.

2.1.2.3 ERICO/Michigan Hanger Co.

2.1.2.4 Grinnell Corp.

2.1.2.5 PHS Industries, Inc.

2.1.3 Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

2.1.4 Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.2 TRAPEZE PIPE HANGERS

2.2.1 Description: Manufacturer Metal Framing System Components selected to support weight of group of medical gas piping.

2.2.2 Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

2.2.3 Standard: MFMA-4.

2.2.4 Channels: Continuous slotted steel channel with intumed lips.

2.2.5 Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.2.6 Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

2.2.7 Metallic Coating: Electropated zinc.

2.3 FASTENER SYSTEMS

2.3.1 Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.3.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3.1.1.1 Hilti, Inc.

2.3.1.1.2 ITW Ramset/Red Head.

2.3.1.1.3 Masterset Fastening Systems, Inc.

2.3.1.1.4 MKT Fastening, LLC.

2.3.1.1.5 Powers Fasteners.

2.3.2 Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.3.2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3.2.1.1 B-Line Systems, Inc.; a division of Cooper Industries.

2.3.2.1.2 Hilti, Inc.

2.3.2.1.3 ITW Ramset/Red Head.

2.3.2.1.4 Powers Fasteners.

2.4 EQUIPMENT SUPPORTS

2.4.1 Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.5 MISCELLANEOUS MATERIALS

2.5.1 Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

2.5.2 Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2.5.2.1 Properties: Nonstaining, noncorrosive, and nongaseous.

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

2.5.2.2 Design Mix: 5000-psi , 28-day compressive strength.

3 PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- 3.1.1 Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- 3.1.2 Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- 3.1.3 Use hangers and supports with galvanized, metallic coatings for that will not have field-applied finish.
- 3.1.4 Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- 3.1.5 Horizontal-Piping Hangers and Supports: Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 2.
- 3.1.6 Vertical-Piping Clamps: Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 6.
- 3.1.7 Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.7.1 Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 - 3.1.7.2 Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- 3.1.8 Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.8.1 Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - 3.1.8.2 C-Clamps (MSS Type 23): For structural shapes.
- 3.1.9 Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
- 3.1.10 Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- 3.1.11 Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

3.1.12 Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

3.2.1 Steel 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 building structure.

3.2.2 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.

3.2.2.1 Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.

3.2.2.2 Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

3.2.3 Fastener System Installation:

3.2.3.1 Install powder-actuated fasteners for use in concrete slabs. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

3.2.3.2 Install mechanical-expansion anchors in concrete. Install fasteners according to manufacturer's written instructions.

3.2.4 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

3.2.5 Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at changes in direction of piping.

3.2.6 Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

3.2.7 Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

3.2.8 Insulated Piping: Comply with the following:

3.2.8.1 Attach clamps and spacers to piping.

3.2.8.1.1 Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

3.3 METAL FABRICATIONS

SECTION 15061 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

- 3.3.1 Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.
- 3.3.2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- 3.3.3 Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - 3.3.3.1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 3.3.3.2 Obtain fusion without undercut or overlap.
 - 3.3.3.3 Remove welding flux immediately.
 - 3.3.3.4 Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.
- 3.4 **ADJUSTING**
 - 3.4.1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
 - 3.4.2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
- 3.5 **PAINTING**
 - 3.5.1 Touch Up: 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.
 - 3.5.1.1 Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
 - 3.5.2 Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9
 - 3.5.3 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 15061

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following hangers and supports for HVAC system piping and equipment:

1.2.1.1 Steel pipe hangers and supports.

1.2.1.2 Thermal-hanger shield inserts.

1.2.1.3 Fastener systems.

1.2.2 Related Sections include the following:

1.2.2.1 Division 13 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.

1.2.2.2 Division 15 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

1.3.1 MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

1.3.2 Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

1.4.1 Product Data: For the following:

1.4.1.1 Steel pipe hangers and supports.

1.4.1.2 Thermal-hanger shield inserts.

1.4.1.3 Powder-actuated fastener systems.

1.4.2 Shop Drawings: Show fabrication and installation details and include calculations for the following:

1.4.3 Welding certificates.

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

1.5 QUALITY ASSURANCE

1.5.1 Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

2 PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

2.2.1 Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

2.2.2 Manufacturers:

2.2.2.1 B-Line Systems, Inc.; a division of Cooper Industries.

2.2.2.2 ERICO/Michigan Hanger Co.

2.2.2.3 Grinnell Corp.

2.2.2.4 PHS Industries, Inc.

2.2.3 Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

2.2.4 Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.2.5 Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 THERMAL-HANGER SHIELD INSERTS

2.3.1 Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

2.3.2 Manufacturers:

2.3.2.1 ERICO/Michigan Hanger Co.

2.3.2.2 PHS Industries, Inc.

2.3.2.3 Pipe Shields, Inc.

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- 2.3.3 Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.
- 2.3.4 Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.
- 2.3.5 For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- 2.3.6 For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- 2.3.7 Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- 2.4.1 Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 2.4.1.1 Manufacturers:
 - 2.4.1.1.1 Hilti, Inc.
 - 2.4.1.1.2 ITW Ramset/Red Head.
 - 2.4.1.1.3 MKT Fastening, LLC.
 - 2.4.1.1.4 Powers Fasteners.
 - 2.4.2 Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 2.4.2.1 Manufacturers:
 - 2.4.2.1.1 B-Line Systems, Inc.; a division of Cooper Industries.
 - 2.4.2.1.2 Hilti, Inc.
 - 2.4.2.1.3 ITW Ramset/Red Head.
 - 2.4.2.1.4 MKT Fastening, LLC.

2.5 MISCELLANEOUS MATERIALS

- 2.5.1 Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

3 PART 3 - EXECUTION

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

3.1 HANGER AND SUPPORT APPLICATIONS

- 3.1.1 Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- 3.1.2 Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- 3.1.3 Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- 3.1.4 Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- 3.1.5 Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.5.1 Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 4.
- 3.1.6 Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.6.1 Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
- 3.1.7 Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.7.1 C-Clamps (MSS Type 23): For structural shapes.
- 3.1.8 Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 3.1.8.1 Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 3.1.8.2 Thermal-Hanger Shield Inserts: For supporting insulated steam and condensate pipe.
- 3.1.9 Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

- 3.2.1 Steel 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 building structure.
- 3.2.2 Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated steam and condensate piping.

SECTION 15062 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

- 3.2.3 Fastener System Installation:
- 3.2.3.1 Install powder-actuated fasteners for use in concrete slabs after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
- 3.2.3.2 Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- 3.2.4 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- 3.2.5 Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves and strainers, NPS 2-1/2 and larger and at changes in direction of piping.
- 3.2.6 Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- 3.2.7 Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- 3.2.8 Insulated Piping: Comply with the following:
- 3.2.8.1 Attach clamps and spacers to piping.
- 3.2.8.1.1 Heating Hot Water Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
- 3.2.8.1.2 Steam and Condensate Piping: Use thermal-hanger shield insert with clamp sized to match OD of insert. Install with insulation same thickness as piping insulation.
- 3.2.8.1.3 Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
- 3.3 ADJUSTING
- 3.3.1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- 3.3.2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.
- END OF SECTION 15062

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SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 Section Includes:

- 1.2.1.1 Pipe labels.

- 1.2.2 Related Work Specified Elsewhere:

- 1.2.2.1 See specifications for medical gas piping for identification requirements for medical gas and vacuum systems.

1.3 COORDINATION

- 1.3.1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

- 1.3.2 Coordinate installation of identifying devices with locations of access panels and doors.

- 1.3.3 Install identifying devices before installing acoustical ceilings and similar concealment.

2 PART 2 - PRODUCTS

2.1 PIPE LABELS

- 2.1.1 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

- 2.1.2 Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

- 2.1.3 Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

- 2.1.4 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.

- 2.1.4.1 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.

SECTION 15076 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

2.1.4.2 Lettering Size: At least 1-1/2 inches on insulated pipe.

3 PART 3 - EXECUTION

3.1 PREPARATION

3.1.1 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.

3.2 PIPE LABEL INSTALLATION

3.2.1 Locate pipe labels as follows:

3.2.1.1 Near each valve and control device.

3.2.1.2 Near each branch connection, including short takeoffs for fixtures. Where flow pattern is not obvious, mark each pipe at branch.

3.2.1.3 Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

3.2.1.4 Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.2.2 Pipe Label Color Schedule:

3.2.2.1 Domestic Water Piping:

3.2.2.1.1 Background Color: White.

3.2.2.1.2 Letter Color: Blue.

3.2.2.2 Sanitary Waste Piping:

3.2.2.2.1 Background Color: Natural.

3.2.2.2.2 Letter Color: Yellow.

END OF SECTION 15076

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Equipment labels.

1.2.1.2 Pipe labels.

1.2.1.3 Duct labels.

1.2.1.4 Valve tags.

1.3 SUBMITTALS

1.3.1 Product Data: For each type of product indicated.

1.3.2 Valve numbering scheme.

1.3.3 Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

1.4.1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

1.4.2 Coordinate installation of identifying devices with locations of access panels and doors.

1.4.3 Install identifying devices before installing acoustical ceilings and similar concealment.

2 PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

2.1.1 Plastic Labels for Equipment:

2.1.1.1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- 2.1.1.2 Letter Color: White.
- 2.1.1.3 Background Color: Blue.
- 2.1.1.4 Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 2.1.1.5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 2.1.1.6 Minimum Letter Size: 1/2 inch. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- 2.1.1.7 Fasteners: Stainless-steel rivets or self-tapping screws.
- 2.1.1.8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 2.1.2 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.

2.2 PIPE LABELS

- 2.2.1 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- 2.2.2 Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- 2.2.3 Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- 2.2.4 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.
 - 2.2.4.1 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.
 - 2.2.4.2 Lettering Size: At least 1-1/2 inches.

2.3 DUCT LABELS

- 2.3.1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- 2.3.2 Letter Color: White.
- 2.3.3 Background Color: Green.

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- 2.3.4 Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- 2.3.5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- 2.3.6 Minimum Letter Size: 1/2 inch
- 2.3.7 Fasteners: Stainless-steel rivets or self-tapping screws.
- 2.3.8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- 2.3.9 Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 2.3.9.1 Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2.3.9.2 Lettering Size: At least 1-1/2 inches.
- 2.4 VALVE TAGS
 - 2.4.1 Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 - 2.4.1.1 Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2.4.1.2 Fasteners: Brass wire-link or beaded chain; or S-hook.
 - 2.4.2 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.
 - 2.4.2.1 Valve-tag schedule shall be included in operation and maintenance data.

3 PART 3 - EXECUTION

3.1 PREPARATION

- 3.1.1 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.

3.2 EQUIPMENT LABEL INSTALLATION

- 3.2.1 Install or permanently fasten labels on each Owner Furnished, Contractor Installed

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

VAV terminal unit.

3.2.2 Locate equipment labels on bottom of unit and visible with ceiling tile removal.

3.3 PIPE LABEL INSTALLATION

3.3.1 Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; and exterior exposed locations as follows:

3.3.1.1 Near each valve and control device.

3.3.1.2 Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3.3.1.3 Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

3.3.1.4 Near major equipment items and other points of origination and termination.

3.3.1.5 Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.3.2 Pipe Label Color Schedule:

3.3.2.1 Steam and Condensate Piping:

3.3.2.1.1 Background Color: Yellow.

3.3.2.1.2 Letter Color: Black.

3.3.2.2 Heating Water Piping:

3.3.2.2.1 Background Color: Black.

3.3.2.2.2 Letter Color: White.

3.4 DUCT LABEL INSTALLATION

3.4.1 Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

3.4.1.1 Blue: For cold-air supply ducts.

3.4.1.2 Green: For return-air ducts.

3.4.2 Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

SECTION 15077 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

- 3.5.1 Install tags on valves and control devices in piping systems, except check valves. Include valves within factory-fabricated equipment units; shutoff valves; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- 3.5.2 Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 3.5.2.1 Valve-Tag Size and Shape: 2-inches, round.
 - 3.5.2.2 Valve-Tag Color: Natural.
 - 3.5.2.3 Letter Color: Black

END OF SECTION 15077

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SECTION 15082 - PLUMBING INSULATION

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 Section Includes:

1.2.1.1 Insulation Materials:

- 1.2.1.1.1 Mineral fiber.

- 1.2.1.2 Adhesives.

- 1.2.1.3 Mastics.

- 1.2.1.4 Field-applied jackets.

- 1.2.2 Related Sections include the following:

- 1.2.2.1 Division 15 Section "HVAC Insulation."

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

- 1.4.1 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.

- 1.4.2 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.

- 1.4.2.1 Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

SECTION 15082 - PLUMBING INSULATION

- 1.5.1 Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
- 1.6 COORDINATION
 - 1.6.1 Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."
 - 1.6.2 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.
 - 1.6.3 Coordinate installation and testing of heat tracing.
- 1.7 SCHEDULING
 - 1.7.1 Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- 2 PART 2 - PRODUCTS
 - 2.1 INSULATION MATERIALS
 - 2.1.1 Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
 - 2.1.2 Products shall not contain asbestos, lead, mercury, or mercury compounds.
 - 2.1.3 Mineral-Fiber, Preformed Pipe Insulation:
 - 2.1.3.1 Products: Subject to compliance with requirements:
 - 2.1.3.1.1 Johns Manville; Micro-Lok.
 - 2.1.3.1.2 Knauf Insulation; 1000 deg Pipe Insulation.
 - 2.1.3.1.3 Owens Corning; Fiberglas Pipe Insulation.
 - 2.1.3.2 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.
 - 2.2 ADHESIVES
 - 2.2.1 Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise

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indicated.

- 2.2.2 Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- 2.2.2.1 Products: Subject to compliance with requirements, provide one of the following:
 - 2.2.2.1.1 Childers Products, Division of ITW; CP-82.
 - 2.2.2.1.2 Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 2.2.2.1.3 ITW TACC, Division of Illinois Tool Works; S-90/80.
 - 2.2.2.1.4 Marathon Industries, Inc.; 225.
 - 2.2.2.1.5 Mon-Eco Industries, Inc.; 22-25.
- 2.2.3 ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 2.2.3.1 Products: Subject to compliance with requirements, provide one of the following:
 - 2.2.3.1.1 Childers Products, Division of ITW; CP-82.
 - 2.2.3.1.2 Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 2.2.3.1.3 ITW TACC, Division of Illinois Tool Works; S-90/80.
 - 2.2.3.1.4 Marathon Industries, Inc.; 225.
 - 2.2.3.1.5 Mon-Eco Industries, Inc.; 22-25.
- 2.3 MASTICS
 - 2.3.1 Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 2.3.2 Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 2.3.2.1 Products: Subject to compliance with requirements, provide one of the following:
 - 2.3.2.1.1 Childers Products, Division of ITW; CP-35.
 - 2.3.2.1.2 Foster Products Corporation, H. B. Fuller Company; 30-90.
 - 2.3.2.1.3 ITW TACC, Division of Illinois Tool Works; CB-50.
 - 2.3.2.1.4 Marathon Industries, Inc.; 590.
 - 2.3.2.1.5 Mon-Eco Industries, Inc.; 55-40.

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- 2.3.2.1.6 Vimasco Corporation; 749.
- 2.3.2.2 Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 2.3.2.3 Service Temperature Range: Minus 20 to plus 180 deg F .
- 2.3.2.4 Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
- 2.3.2.5 Color: White.

3 PART 3 - EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 3.1.1.1 Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 3.1.1.2 Verify that surfaces to be insulated are clean and dry.
 - 3.1.1.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- 3.2.1 Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- 3.2.2 Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
- 3.2.3 Mix insulating cements with clean potable water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- 3.3.1 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.
- 3.3.2 Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each pipe system as specified in insulation system schedules.
- 3.3.3 Install insulation with longitudinal seams at top and bottom of horizontal runs.
- 3.3.4 Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

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- 3.3.5 Keep insulation materials dry during application and finishing.
- 3.3.6 Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- 3.3.7 Install insulation with least number of joints practical.
- 3.3.8 Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
- 3.3.8.1 Install insulation continuously through hangers.
- 3.3.9 Apply adhesives and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- 3.3.10 Install insulation with factory-applied jackets as follows:
 - 3.3.10.1 Draw jacket tight and smooth.
 - 3.3.10.2 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.
 - 3.3.10.3 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.
 - 3.3.10.3.1 For below ambient services, apply vapor-barrier mastic over staples.
 - 3.3.10.4 Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - 3.3.10.5 Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.
- 3.3.11 Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 3.3.12 Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- 3.3.13 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.
- 3.3.14 For above ambient services, do not install insulation to the following:
 - 3.3.14.1 Testing agency labels and stamps.
 - 3.3.14.2 Nameplates and data plates.

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3.3.14.3 Cleanouts.

3.4 PENETRATIONS

3.4.1 Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.4.2 Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

3.4.2.1 Comply with requirements in Division 7 Section "Through-Penetration Firestop Systems" for firestopping and fire-resistive joint sealers.

3.4.2.2 System used shall be UL tested for fire rating required.

3.5 GENERAL PIPE INSULATION INSTALLATION

3.5.1 Insulation Installation on Fittings, Valves, and Unions:

3.5.1.1 Install insulation over fittings, valves, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

3.5.1.2 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.

3.5.1.3 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.

3.5.1.4 Insulate valves using preformed fitting 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.

3.5.1.5 Insulate 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.

3.5.1.6 Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

3.6 MINERAL-FIBER INSULATION INSTALLATION

3.6.1 Insulation Installation on Straight Pipes and Tubes:

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- 3.6.1.1 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
- 3.6.1.2 For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
- 3.6.1.3 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.
- 3.6.2 Insulation Installation on Pipe Fittings and Elbows:
 - 3.6.2.1 Install preformed sections of same material as straight segments of pipe insulation when available.
 - 3.6.2.2 When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation.
- 3.6.3 Insulation Installation on Valves and Pipe Specialties:
 - 3.6.3.1 Install preformed sections of same material as straight segments of pipe insulation when available.
 - 3.6.3.2 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3.6.3.3 Install insulation to flanges as specified for flange insulation application.
- 3.7 PIPING INSULATION SCHEDULE, GENERAL
 - 3.7.1 Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range.
 - 3.7.2 Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 3.7.2.1 Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- 3.8 INDOOR PIPING INSULATION SCHEDULE
 - 3.8.1 Domestic Cold Water: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 3.8.2 Domestic Hot and Recirculated Hot Water: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 3.8.3 Condensate and Equipment Drain Water below 60 Deg F: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

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3.8.4 Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving
Condensate and Equipment Drain Water below 60 Deg F and above 80 Deg F:
Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

END OF SECTION 15082

SECTION 15083 - HVAC INSULATION

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Insulation Materials:

1.2.1.1.1 Mineral fiber.

1.2.1.2 Insulating cements.

1.2.1.3 Adhesives.

1.2.1.4 Mastics.

1.2.1.5 Sealants.

1.2.1.6 Factory-applied jackets.

1.2.1.7 Field-applied jackets.

1.2.1.8 Tapes.

1.2.1.9 Securements.

1.2.2 Related Sections:

1.2.2.1 Division 15 Section "Plumbing Insulation."

1.3 SUBMITTALS

1.3.1 Product Data: For each type of product indicated in "Summary" Article. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1.4 QUALITY ASSURANCE

1.4.1 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.

1.4.2 Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products

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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.

- 1.4.2.1 Insulation: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

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

- 1.5.2 Damaged Insulation: Insulation that gets wet shall not be used. Immediately remove wet insulation from site.

1.6 COORDINATION

- 1.6.1 Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section "Hangers and Supports for HVAC Piping and Equipment."

- 1.6.2 Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

- 1.6.3 Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- 1.7.1 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.

- 1.7.2 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

2 PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- 2.1.1 Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

- 2.1.2 Products shall not contain asbestos, lead, mercury, or mercury compounds.

- 2.1.2.1 Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with

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ASTM C 547, Type I, Grade A; mineral or glass fibers bonded with a thermosetting resin. Factory applied jacket requirements are specified in "Factory-Applied Jackets: Article.

- 2.1.2.2 Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- 2.1.3 Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 2.1.3.1 Products: Subject to compliance with requirements, provide one of the following:
 - 2.1.3.1.1 CertainTeed Corp.; Duct Wrap.
 - 2.1.3.1.2 Johns Manville; Microlite.
 - 2.1.3.1.3 Knauf Insulation; Duct Wrap.
 - 2.1.3.1.4 Owens Corning; All-Service Duct Wrap.
 - 2.1.4 Mineral-Fiber, Preformed Pipe Insulation:
 - 2.1.4.1 Products: Subject to compliance with requirements, provide one of the following:
 - 2.1.4.1.1 Johns Manville; Micro-Lok.
 - 2.1.4.1.2 Knauf Insulation; 1000 Pipe Insulation.
 - 2.1.4.1.3 Owens Corning; Fiberglas Pipe Insulation.

2.2 INSULATING CEMENTS

- 2.2.1 Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - 2.2.1.1 Products: Subject to compliance with requirements, :
 - 2.2.1.1.1 Insulco, Division of MFS, Inc.; Triple I.
 - 2.2.1.1.2 P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 ADHESIVES

- 2.3.1 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.
 - 2.3.1.1 Products: Subject to compliance with requirements, provide products from one of the following:

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- 2.3.1.1.1 Childers Products, Division of ITW; CP-96.
- 2.3.1.1.2 Foster Products Corporation, H. B. Fuller Company; 81-33.
- 2.3.2 Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- 2.3.2.1 Products: Subject to compliance with requirements, provide products from one of the following:
 - 2.3.2.1.1 Childers Products, Division of ITW; CP-82.
 - 2.3.2.1.2 Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 2.3.2.1.3 ITW TACC, Division of Illinois Tool Works; S-90/80.
 - 2.3.2.1.4 Marathon Industries, Inc.; 225.
 - 2.3.2.1.5 Mon-Eco Industries, Inc.; 22-25.
- 2.3.3 ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 2.3.3.1 Products: Subject to compliance with requirements, provide products from one of the following:
 - 2.3.3.1.1 Childers Products, Division of ITW; CP-82.
 - 2.3.3.1.2 Foster Products Corporation, H. B. Fuller Company; 85-20.
 - 2.3.3.1.3 ITW TACC, Division of Illinois Tool Works; S-90/80.
 - 2.3.3.1.4 Marathon Industries, Inc.; 225.
 - 2.3.3.1.5 Mon-Eco Industries, Inc.; 22-25.
- 2.4 MASTICS
- 2.4.1 Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- 2.4.2 Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 2.4.2.1 Products: Subject to compliance with requirements, provide products from one of the following:
 - 2.4.2.1.1 Childers Products, Division of ITW; CP-35.
 - 2.4.2.1.2 Foster Products Corporation, H. B. Fuller Company; 30-90.

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- 2.4.2.1.3 ITW TACC, Division of Illinois Tool Works; CB-50.
- 2.4.2.1.4 Marathon Industries, Inc.; 590.
- 2.4.2.1.5 Mon-Eco Industries, Inc.; 55-40.
- 2.4.2.1.6 Vimasco Corporation; 749.
- 2.4.2.2 Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
- 2.4.2.3 Service Temperature Range: Minus 20 to plus 180 deg F.
- 2.4.2.4 Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
- 2.4.2.5 Color: White.

2.5 SEALANTS

- 2.5.1 Joint Sealants:
- 2.5.2 FSK Jacket Flashing Sealants:
 - 2.5.2.1 Products: Subject to compliance with requirements, provide products from one of the following:
 - 2.5.2.1.1 Childers Products, Division of ITW; CP-76-8.
 - 2.5.2.1.2 Foster Products Corporation, H. B. Fuller Company; 95-44.
 - 2.5.2.1.3 Marathon Industries, Inc.; 405.
 - 2.5.2.1.4 Mon-Eco Industries, Inc.; 44-05.
 - 2.5.2.1.5 Vimasco Corporation; 750.
 - 2.5.2.2 Materials shall be compatible with insulation materials, jackets, and substrates.
 - 2.5.2.3 Fire- and water-resistant, flexible, elastomeric sealant.
 - 2.5.2.4 Service Temperature Range: Minus 40 to plus 250 deg F.
 - 2.5.2.5 Color: Aluminum.
- 2.5.3 ASJ Flashing Sealants:
 - 2.5.3.1 Products: Subject to compliance with requirements, :
 - 2.5.3.1.1 Childers Products, Division of ITW; CP-76.

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- 2.5.3.2 Materials shall be compatible with insulation materials, jackets, and substrates.
- 2.5.3.3 Fire- and water-resistant, flexible, elastomeric sealant.
- 2.5.3.4 Service Temperature Range: Minus 40 to plus 250 deg F.
- 2.5.3.5 Color: White.
- 2.5.3.6 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).

2.6 FACTORY-APPLIED JACKETS

- 2.6.1 Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 2.6.1.1 ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2.6.1.2 FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.7 TAPES

- 2.7.1 ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 - 2.7.1.1 Products: Subject to compliance with requirements, :
 - 2.7.1.1.1 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - 2.7.1.1.2 Compac Corp.; 104 and 105.
 - 2.7.1.1.3 Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - 2.7.1.1.4 Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - 2.7.1.2 Width: 3 inches.
 - 2.7.1.3 Thickness: 11.5 mils.
 - 2.7.1.4 Adhesion: 90 ounces force/inch in width.
 - 2.7.1.5 Elongation: 2 percent.
 - 2.7.1.6 Tensile Strength: 40 lbf/inch in width.
 - 2.7.1.7 ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- 2.7.2 FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with

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acrylic adhesive; complying with ASTM C 1136.

2.7.2.1 Products: Subject to compliance with requirements, provide products from one of the following:

2.7.2.1.1 ABI, Ideal Tape Division; 491 AWF FSK.

2.7.2.1.2 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

2.7.2.1.3 Compac Corporation; 110 and 111.

2.7.2.1.4 Venture Tape; 1525 CW NT, 1528, CW and 15 CW/SQ.

2.7.2.2 Width: 3 inches.

2.7.2.3 Thickness: 6.5 mils.

2.7.2.4 Adhesion: 90 ounces force/inch in width.

2.7.2.5 Elongation: 2 percent.

2.7.2.6 Tensile Strength: 40 lbf/inch in width.

2.7.2.7 FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.7.3 Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

2.7.3.1 Products: Subject to compliance with requirements,:

2.7.3.1.1 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

2.7.3.1.2 Compac Corp.; 120.

2.7.3.1.3 Ideal Tape Co., Inc., an American Bilrite Company; 488 AWF.

2.7.3.1.4 Venture Tape; 3520 CW.

2.7.3.2 Width: 2 inches.

2.7.3.3 Thickness: 3.7 mils.

2.7.3.4 Adhesion: 100 ounces force/inch in width.

2.7.3.5 Elongation: 5 percent.

2.7.3.6 Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

2.8.1 Insulation Pins and Hangers:

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- 2.8.1.1 Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- 2.8.1.1.1 Products: Subject to compliance with requirements:
- 2.8.1.1.1.1 AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
- 2.8.1.1.1.2 GEMCO; Press and Peel.
- 2.8.1.1.1.3 Midwest Fasteners, Inc.; Self Stick.
- 2.8.1.1.2 Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
- 2.8.1.1.3 Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
- 2.8.1.1.4 Adhesive-backed base with a peel-off protective cover.
- 2.8.1.2 Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- 2.8.1.2.1 Products: Subject to compliance with requirements:
- 2.8.1.2.1.1 AGM Industries, Inc.; RC-150.
- 2.8.1.2.1.2 GEMCO; R-150.
- 2.8.1.2.1.3 Midwest Fasteners, Inc.; WA-150.
- 2.8.1.2.1.4 Nelson Stud Welding; Speed Clips.
- 2.8.1.2.2 Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

2.9 FIELD-APPLIED JACKETS

- 2.9.1 Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- 2.9.2 Metal Jacket:
- 2.9.2.1 Products: Subject to compliance with requirements, provide one of the following:
- 2.9.2.1.1 Childers Products, Division of ITW; Metal Jacketing Systems.
- 2.9.2.1.2 PABCO Metals Corporation; Surefit.
- 2.9.2.1.3 RPR Products, Inc.; Insul-Mate.

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- 2.9.2.2 Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
- 2.9.2.2.1 Factory cut and rolled to size.
- 2.9.2.2.2 Material, finish, and thickness are indicated in field-applied jacket schedules.
- 2.9.2.3 Factory-Fabricated Fitting Covers:
 - 2.9.2.3.1 Same material, finish, and thickness as jacket.
 - 2.9.2.3.2 Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 2.9.2.3.3 Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3 PART 3 - EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 3.1.1.1 Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 3.1.1.2 Verify that surfaces to be insulated are clean and dry.
 - 3.1.1.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- 3.2.1 Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- 3.2.2 Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 3.2.2.1 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.
- 3.2.3 Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- 3.2.4 Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- 3.3.1 Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and

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pipng including fittings, valves, and specialties.

- 3.3.2 Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- 3.3.3 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.
- 3.3.4 Install insulation with longitudinal seams at top and bottom of horizontal runs.
- 3.3.5 Install multiple layers of insulation with longitudinal and end seams staggered.
- 3.3.6 Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- 3.3.7 Keep insulation materials dry during application and finishing.
- 3.3.8 Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- 3.3.9 Install insulation with least number of joints practical.
 - 3.3.9.1 Install insulation continuously through hangers and around anchor attachments.
 - 3.3.9.2 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.
 - 3.3.9.3 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.
- 3.3.10 Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- 3.3.11 Install insulation with factory-applied jackets as follows:
 - 3.3.11.1 Draw jacket tight and smooth.
 - 3.3.11.2 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.
 - 3.3.11.3 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.
 - 3.3.11.4 Cover joints and seams with tape as recommended by insulation material

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manufacturer to maintain vapor seal.

- 3.3.12 Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- 3.3.13 Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- 3.3.14 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.

3.4 PENETRATIONS

- 3.4.1 Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

3.5 GENERAL PIPE INSULATION INSTALLATION

- 3.5.1 Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- 3.5.2 Insulation Installation on Fittings, Valves, Strainers, and Unions:
 - 3.5.2.1 Install insulation over fittings, valves, strainers, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 3.5.2.2 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.
 - 3.5.2.3 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.
 - 3.5.2.4 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.
 - 3.5.2.5 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

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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.

- 3.5.2.6 Insulate 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.
- 3.5.2.7 Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- 3.5.2.8 Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- 3.5.2.9 Finish exposed surfaces with a metal jacket.

3.6 MINERAL-FIBER INSULATION INSTALLATION

- 3.6.1 Insulation Installation on Straight Pipes and Tubes:
 - 3.6.1.1 Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - 3.6.1.2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3.6.1.3 For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
 - 3.6.1.4 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.
- 3.6.2 Insulation Installation on Pipe Flanges:
 - 3.6.2.1 Install preformed pipe insulation to outer diameter of pipe flange.
 - 3.6.2.2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - 3.6.2.3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - 3.6.2.4 Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.
- 3.6.3 Insulation Installation on Pipe Fittings and Elbows:

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- 3.6.3.1 Install preformed sections of same material as straight segments of pipe insulation when available.
- 3.6.3.2 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.
- 3.6.4 Insulation Installation on Valves and Pipe Specialties:
 - 3.6.4.1 Install preformed sections of same material as straight segments of pipe insulation when available.
 - 3.6.4.2 When preformed sections are not available, install mitered sections of pipe insulation to valve body.
 - 3.6.4.3 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - 3.6.4.4 Install insulation to flanges as specified for flange insulation application.
- 3.6.5 Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - 3.6.5.1 Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 3.6.5.2 Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3.6.5.3 Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - 3.6.5.3.1 On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - 3.6.5.3.2 On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - 3.6.5.3.3 Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - 3.6.5.3.4 Do not overcompress insulation during installation.
 - 3.6.5.3.5 Impale insulation over pins and attach speed washers.
 - 3.6.5.3.6 Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

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- 3.6.5.4 For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- 3.6.5.4.1 Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
- 3.6.5.4.2 Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
- 3.6.5.5 Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
- 3.6.5.6 Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 3.6.5.7 Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- 3.6.6 Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- 3.6.6.1 Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
- 3.6.6.2 Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
- 3.6.6.3 Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
- 3.6.6.3.1 On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
- 3.6.6.3.2 On duct sides with dimensions larger than 18 inches , space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
- 3.6.6.3.3 Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
- 3.6.6.3.4 Do not overcompress insulation during installation.

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- 3.6.6.3.5 Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- 3.6.6.4 For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- 3.6.6.4.1 Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
- 3.6.6.4.2 Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
- 3.6.6.5 Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- 3.6.6.6 Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 DUCT INSULATION SCHEDULE, GENERAL

- 3.7.1.1 Plenums and Ducts Requiring Insulation: Supply air.
- 3.7.2 Items Not Insulated:
- 3.7.2.1 Factory-insulated flexible ducts.
- 3.7.2.2 Factory-insulated plenums and casings.
- 3.7.2.3 Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- 3.8.1.1 Supply-air duct insulation: Mineral-fiber blanket: 2 inches thick, 0.75-lb/cu. ft. nominal density, minimum R-6 value.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- 3.9.1 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.

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3.10 INDOOR PIPING INSULATION SCHEDULE

- 3.10.1.1.1 Condensate and Equipment Drain Water below 60 Deg F and Above 80 Deg F: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- 3.10.1.1.2 Heating-Hot-Water Supply and Return: Mineral-fiber, preformed pipe, Type I; 1 inch thick.
- 3.10.1.1.3 Steam and Condensate Piping: Mineral-fiber, preformed pipe, Type I; 2 inches thick.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- 3.11.1 Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- 3.11.2 Piping, Exposed: All.
- 3.11.2.1 Stainless Steel, Type 304, Smooth 2B Finish with Z-Shaped Locking Seam: 0.016 inch thick.

3.12

END OF SECTION 15083

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following general-duty valves:

- 1.2.1.1 Copper-alloy ball valves.

- 1.2.2 Related Sections include the following:

- 1.2.2.1 Division 15 Sections for medical gas valves.

1.3 DEFINITIONS

- 1.3.1 The following are standard abbreviations for valves:

- 1.3.1.1 CWP: Cold working pressure.

- 1.3.1.2 PTFE: Polytetrafluoroethylene plastic.

- 1.3.1.3 TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- 1.4.1 Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

- 1.5.1 NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- 1.6.1 Prepare valves for shipping as follows:

- 1.6.1.1 Protect internal parts against rust and corrosion.

- 1.6.1.2 Protect threads.

- 1.6.1.3 Set ball valves open to minimize exposure of functional surfaces.

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

- 1.6.2 Use the following precautions during storage:
 - 1.6.2.1 Maintain valve end protection.
 - 1.6.2.2 Store valves indoors and maintain at higher than ambient dew-point temperature.
- 2 PART 2 - PRODUCTS
 - 2.1 MANUFACTURERS
 - 2.1.1 In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 2.1.1.1 Manufacturers:
 - 2.2 VALVES, GENERAL
 - 2.2.1 Refer to Part 3 "Valve Applications" Article for applications of valves.
 - 2.2.2 Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
 - 2.2.3 Valve Sizes: Same as upstream pipe, unless otherwise indicated.
 - 2.2.4 Valve Actuators:
 - 2.2.4.1 Lever Handle: For quarter-turn valves NPS 6 and smaller.
 - 2.2.5 Extended Valve Stems: On insulated valves.
 - 2.2.5.1 Solder Joint: With sockets according to ASME B16.18.
 - 2.2.5.1.1 Caution: Use solder with melting point below 421 deg F for ball valves.
 - 2.2.5.2 Threaded: With threads according to ASME B1.20.1.
 - 2.3 COPPER-ALLOY BALL VALVES
 - 2.3.1 Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
 - 2.3.1.1.1 Crane Co.; Crane Valve Group; Crane Valves.
 - 2.3.1.1.2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - 2.3.1.1.3 Crane Co.; Crane Valve Group; Stockham Div.
 - 2.3.1.1.4 Grinnell Corporation.
 - 2.3.1.1.5 Hammond Valve.

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

- 2.3.1.1.6 Milwaukee Valve Company.
- 2.3.1.1.7 NIBCO INC.
- 2.3.1.1.8 Watts Industries, Inc.; Water Products Div.
- 2.3.2 Copper-Alloy Ball Valves, General: MSS SP-110.
- 2.3.3 Two-Piece, Copper-Alloy Ball Valves: Bronze body with full regular-port, chrome-plated bronze ball; PTFE or TFE seats; and 400-psig minimum CWP rating and blowout-proof stem, threaded or solder joint.

3 PART 3 - EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 3.1.1.1 Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.1.2 Examine valve interior for cleanliness, freedom from foreign matter, and corrosion.
- 3.1.3 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- 3.1.4 Examine threads on valve and mating pipe for form and cleanliness.
- 3.1.5 Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

- 3.2.1 Domestic Water Piping: Use the following types of valves:
 - 3.2.1.1 Ball Valves, NPS 2 and Smaller: Two-piece, 400-psig CWP rating, copper alloy.
 - 3.2.1.2 End Connections: Solder-joint or threaded ends.

3.3 VALVE INSTALLATION

- 3.3.1 Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- 3.3.2 Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- 3.3.3 Locate valves for easy access and provide separate support where necessary.
- 3.3.4 Install valves in horizontal piping with stem at or above center of pipe.

SECTION 15111 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

3.3.5 Install valves in position to allow full stem movement.

3.4 JOINT CONSTRUCTION

3.4.1 Refer to Division 15 Section "Domestic Water Piping" for basic piping joint construction.

3.5 ADJUSTING

3.5.1 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.

END OF SECTION 15111

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Bronze ball valves.

1.2.1.2 Bronze swing check valves.

1.2.1.3 Bronze gate valves.

1.2.2 Related Sections:

1.2.2.1 Division 15 HVAC piping Sections for specialty valves applicable to those Sections only.

1.2.2.2 Division 15 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

1.3.1 CWP: Cold working pressure.

1.3.2 EPDM: Ethylene propylene copolymer rubber.

1.3.3 NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3.4 NRS: Nonrising stem.

1.3.5 SWP: Steam working pressure.

1.4 SUBMITTALS

1.4.1 Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

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

1.5.2 ASME Compliance:

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

- 1.5.2.1 ASME B31.1 for power piping valves.
- 1.5.2.2 ASME B31.9 for building services piping valves.
- 1.6 DELIVERY, STORAGE, AND HANDLING
 - 1.6.1 Prepare valves for shipping as follows:
 - 1.6.1.1 Protect internal parts against rust and corrosion.
 - 1.6.1.2 Protect threaded ends.
 - 1.6.1.3 Set ball valves open to minimize exposure of functional surfaces.
 - 1.6.1.4 Block check valves in either closed or open position.
 - 1.6.2 Use the following precautions during storage:
 - 1.6.2.1 Maintain valve end protection.
 - 1.6.2.2 Store valves indoors and maintain at higher than ambient dew point temperature.
 - 1.6.3 Do not use stems as lifting points.
- 2 PART 2 - PRODUCTS
 - 2.1 GENERAL REQUIREMENTS FOR VALVES
 - 2.1.1 Refer to HVAC valve schedule articles for applications of valves.
 - 2.1.2 Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
 - 2.1.3 Valve Sizes: Same as upstream piping unless otherwise indicated.
 - 2.1.4 Valve Actuator Types:
 - 2.1.4.1 Handwheel: For valves other than quarter-turn types.
 - 2.1.4.2 Handlever: For quarter-turn valves NPS 6 and smaller.
 - 2.1.5 Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 2.1.5.1 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.
 - 2.1.5.2 Gate Valves: With extended necks.
 - 2.1.6 Valve-End Connections:

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

2.1.6.1 Solder Joint: With sockets according to ASME B16.18.

2.1.6.2 Threaded: With threads according to ASME B1.20.1.

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

2.2 BRONZE BALL VALVES

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

2.2.1.1 Manufacturers: Subject to compliance with requirements,:

2.2.1.1.1 Conbraco Industries, Inc.; Apollo Valves.

2.2.1.1.2 Crane Co.; Crane Valve Group; Crane Valves.

2.2.1.1.3 Hammond Valve.

2.2.1.1.4 Lance Valves; a division of Advanced Thermal Systems, Inc.

2.2.1.1.5 Milwaukee Valve Company.

2.2.1.1.6 NIBCO INC.

2.2.1.1.7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2.2.1.2 Description:

2.2.1.2.1 Standard: MSS SP-110.

2.2.1.2.2 CWP Rating: 400 psig .

2.2.1.2.3 Body Design: Two piece.

2.2.1.2.4 Body Material: Bronze.

2.2.1.2.5 Ends: Threaded.

2.2.1.2.6 Seats: PTFE or TFE.

2.2.1.2.7 Stem: Stainless steel.

2.2.1.2.8 Ball: Stainless steel, vented.

2.2.1.2.9 Port: Full.

2.3 BRONZE SWING CHECK VALVES

2.3.1 Class 125, Bronze Swing Check Valves with Bronze Disc:

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- 2.3.1.1 Manufacturers: Subject to compliance with requirements,:
- 2.3.1.1.1 American Valve, Inc.
- 2.3.1.1.2 Crane Co.; Crane Valve Group; Crane Valves.
- 2.3.1.1.3 Crane Co.; Crane Valve Group; Jenkins Valves.
- 2.3.1.1.4 Crane Co.; Crane Valve Group; Stockham Division.
- 2.3.1.1.5 Hammond Valve.
- 2.3.1.1.6 Kitz Corporation.
- 2.3.1.1.7 Milwaukee Valve Company.
- 2.3.1.1.8 NIBCO INC.
- 2.3.1.1.9 Powell Valves.
- 2.3.1.1.10 Red-White Valve Corporation.
- 2.3.1.1.11 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2.3.1.1.12 Zy-Tech Global Industries, Inc.
- 2.3.1.2 Description:
- 2.3.1.2.1 Standard: MSS SP-80, Type 3.
- 2.3.1.2.2 CWP Rating: 200 psig .
- 2.3.1.2.3 Body Design: Horizontal flow.
- 2.3.1.2.4 Body Material: ASTM B 62, bronze.
- 2.3.1.2.5 Ends: Threaded.
- 2.3.1.2.6 Disc: Bronze.

2.4 BRONZE GATE VALVES

- 2.4.1 Class 125, NRS Bronze Gate Valves:
- 2.4.1.1 Manufacturers: Subject to compliance with requirements, provide products from one of the following:
- 2.4.1.1.1 Crane Co.; Crane Valve Group; Crane Valves.
- 2.4.1.1.2 Crane Co.; Crane Valve Group; Jenkins Valves.

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- 2.4.1.1.3 Crane Co.; Crane Valve Group; Stockham Division.
- 2.4.1.1.4 Hammond Valve.
- 2.4.1.1.5 Kitz Corporation.
- 2.4.1.1.6 Legend Valve.
- 2.4.1.1.7 Milwaukee Valve Company.
- 2.4.1.1.8 NIBCO INC.
- 2.4.1.1.9 Red-White Valve Corporation.
- 2.4.1.1.10 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2.4.1.2 Description:
 - 2.4.1.2.1 Standard: MSS SP-80, Type I.
 - 2.4.1.2.2 CWP Rating: 200 psig .
 - 2.4.1.2.3 Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
 - 2.4.1.2.4 Ends: Threaded.
 - 2.4.1.2.5 Stem: Bronze.
 - 2.4.1.2.6 Disc: Solid wedge; bronze.
 - 2.4.1.2.7 Packing: Asbestos free.
 - 2.4.1.2.8 Handwheel: Malleable iron.

3 PART 3 - EXECUTION

3.1 EXAMINATION

- 3.1.1 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.
- 3.1.2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- 3.1.3 Examine threads on valve and mating pipe for form and cleanliness.
- 3.1.4 Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

SECTION 15112 - GENERAL-DUTY VALVES FOR HVAC PIPING

- 3.2.1 Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- 3.2.2 Locate valves for easy access and provide separate support where necessary.
- 3.2.3 Install valves in horizontal piping with stem at or above center of pipe.
- 3.2.4 Install valves in position to allow full stem movement.
- 3.2.5 Install swing check valves in horizontal position with hinge pin level.
- 3.3 **ADJUSTING**
- 3.3.1 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.
- 3.4 **GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**
- 3.4.1 If valve applications are not indicated, use the following:
 - 3.4.1.1 Shutoff Service: Ball or gate valves.
- 3.4.2 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.
- 3.4.3 Select valves, except wafer types, with the following end connections:
 - 3.4.3.1 For Copper Tubing, NPS 2 and Smaller: Threaded ends.
 - 3.4.3.2 For Steel Piping, NPS 2 and Smaller: Threaded ends.
- 3.5 **STEAM AND CONDENSATE VALVE SCHEDULE**
- 3.5.1 Pipe NPS 2 and Smaller:
 - 3.5.1.1 Bronze Gate Valves: Class 125, NRS, bronze.
 - 3.5.1.2 Bronze Swing Check Valves: Class 125, bronze disc.
- 3.6 **HEATING-WATER VALVE SCHEDULE**
- 3.6.1 Pipe NPS 2 and Smaller:
 - 3.6.1.1 Ball Valves: Two piece, full port, bronze with stainless-steel trim.
 - 3.6.1.2 Bronze Swing Check Valves: Class 125, bronze disc.

END OF SECTION 15112

SECTION 15140 - DOMESTIC WATER PIPING

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 Section Includes:

- 1.2.1.1 Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

1.3 SUBMITTALS

- 1.3.1 Products: Copper pipe and fittings.

- 1.3.2 Shop Drawings: Provide shop drawings for all piping systems. Include location of valves.

- 1.3.3 Inspection and test reports.

1.4 QUALITY ASSURANCE

- 1.4.1 Piping materials shall bear label, stamp, or other markings of specified testing agency.

- 1.4.2 Comply with NSF 61 for potable domestic water piping and components.

1.5 DELIVERY, STORAGE, AND HANDLING

- 1.5.1 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.

1.6 PROJECT CONDITIONS

- 1.6.1.1 Notify Owner and Architect no fewer than seven days in advance of proposed interruption of water service.

- 1.6.1.2 Do not proceed with interruption of water service without Architect's or Owner's written permission.

1.7 COORDINATION

- 1.7.1 Coordinate piping installations with work of all other trades.

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- 1.7.2 Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- 1.7.3 Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors and Frames."

2 PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- 2.1.1 Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 2.1.1.1 Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2.1.1.2 Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 2.1.1.3 Copper Unions:
 - 2.1.1.3.1 MSS SP-123
 - 2.1.1.3.2 Cast-copper-alloy, hexagonal-stock body.
 - 2.1.1.3.3 Ball-and-socket, metal-to-metal seating surfaces.
 - 2.1.1.3.4 Solder-joint or threaded ends.
 - 2.1.1.4 Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

3 PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- 3.1.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Existing piping shown was obtained from Record Drawings. Field verify locations of existing piping.
- 3.1.2 Install domestic water piping level without pitch and plumb.
- 3.1.3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated.
- 3.1.4 Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- 3.1.5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

SECTION 15140 - DOMESTIC WATER PIPING

- 3.1.6 Install piping to permit valve servicing.
- 3.1.7 Install nipples, unions, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- 3.1.8 Install piping free of sags and bends.
- 3.1.9 Install fittings for changes in direction and branch connections.
- 3.2 JOINT CONSTRUCTION
 - 3.2.1 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 3.2.2 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
 - 3.2.3 Threaded Joints:
 - 3.2.3.1 Join pipe fittings and valves as follows:
 - 3.2.3.1.1 Install solder-joint to threaded-joint adapter at pipe end.
 - 3.2.3.1.2 Apply appropriate tape or thread compound to external pipe threads.
 - 3.2.3.1.3 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - 3.2.4 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.
 - 3.2.5 Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
- 3.3 HANGER AND SUPPORT INSTALLATION
 - 3.3.1 Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 3.3.1.1 Vertical Piping: MSS Type 8 or 42, clamps.
 - 3.3.1.2 Individual, Straight, Horizontal Piping Runs:
 - 3.3.1.2.1 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - 3.3.2 Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
 - 3.3.3 Install hangers for copper tubing with the following maximum horizontal spacing and

SECTION 15140 - DOMESTIC WATER PIPING

minimum rod diameters:

- 3.3.3.1 NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
- 3.3.3.2 NPS 1 and Larger: 72 inches with 3/8-inch rod.
- 3.3.4 Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.4 CONNECTIONS

- 3.4.1 Drawings indicate general arrangement of piping, fittings, and specialties.
- 3.4.2 Install piping adjacent to equipment and machines to allow service and maintenance.
- 3.4.3 Install unions at all threaded valves.

3.5 IDENTIFICATION

- 3.5.1 Identify system components. Comply with requirements in Division 15 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- 3.5.2 Label pressure piping with system operating pressure.

3.6 FIELD QUALITY CONTROL

- 3.6.1 Perform tests and inspections.
- 3.6.2 Piping Inspections:
 - 3.6.2.1 Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 3.6.2.2 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:
 - 3.6.2.2.1 Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 3.6.2.2.2 Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3.6.2.3 Re-inspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for re-inspection.
 - 3.6.2.4 Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

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- 3.6.3 Piping Tests:
 - 3.6.3.1 Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 3.6.3.2 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.
 - 3.6.3.3 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.
 - 3.6.3.4 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.
 - 3.6.3.5 Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 3.6.3.6 Prepare reports for tests and for corrective action required.
- 3.6.4 Domestic water piping will be considered defective if it does not pass tests and inspections.
- 3.6.5 Prepare test and inspection reports.
- 3.7 **ADJUSTING**
 - 3.7.1 Perform the following adjustments before operation:
 - 3.7.1.1 Open shutoff valves to fully open position.
 - 3.7.1.2 Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - 3.7.1.2.1 Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - 3.7.1.3 Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - 3.7.1.4 Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - 3.7.1.5 Check plumbing specialties and verify proper settings, adjustments, and operation.

SECTION 15140 - DOMESTIC WATER PIPING

3.8 PIPING SCHEDULE

- 3.8.1 Aboveground domestic water piping: Hard copper tube, ASTM B 88, Type L; cast- or wrought- copper solder-joint fittings; and soldered joints. Provide threaded joints at valves.

END OF SECTION 15140

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following domestic water piping specialties:

- 1.2.1.1 Balancing valves.
1.2.1.2 Water hammer arresters.
1.2.1.3 Air vents.

1.3 PERFORMANCE REQUIREMENTS

- 1.3.1 Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- 1.4.1 Product Data: For each type of product indicated.
1.4.2 Field quality-control test reports.
1.4.3 Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- 1.5.1 NSF Compliance:
1.5.1.1 Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

2 PART 2 - PRODUCTS

2.1 BALANCING VALVES

- 2.1.1 Copper-Alloy Calibrated Balancing Valves:
2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 2.1.1.1.1 Armstrong International, Inc.
- 2.1.1.1.2 ITT Industries; Bell & Gossett Div.
- 2.1.1.1.3 Taco, Inc.
- 2.1.1.1.4 Watts Industries, Inc.; Water Products Div.
- 2.1.1.2 Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
- 2.1.1.3 Body: bronze,
- 2.1.1.4 Size: NPS ½.
- 2.1.1.5 Setting: 0.15 gpm minimum.
- 2.1.1.6 Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.2 WATER HAMMER ARRESTERS

- 2.2.1 Water Hammer Arresters:
 - 2.2.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.2.1.1.1 AMTROL, Inc.
 - 2.2.1.1.2 Josam Company.
 - 2.2.1.1.3 PPP Inc.
 - 2.2.1.1.4 Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - 2.2.1.1.5 Watts Drainage Products Inc.
 - 2.2.1.1.6 Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2.2.1.2 Standard: ASSE 1010 or PDI-WH 201.
 - 2.2.1.3 Type: Metal bellows.
 - 2.2.1.4 Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.3 AIR VENTS

- 2.3.1 Bolted-Construction Automatic Air Vents:

SECTION 15145 - DOMESTIC WATER PIPING SPECIALTIES

- 2.3.1.1 Body: Bronze.
- 2.3.1.2 Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
- 2.3.1.3 Float: Replaceable, corrosion-resistant metal.
- 2.3.1.4 Mechanism and Seat: Stainless steel.
- 2.3.1.5 Size: NPS 1/2 minimum inlet.
- 2.3.1.6 Inlet and Vent Outlet End Connections: Threaded.

3 PART 3 - EXECUTION

3.1 INSTALLATION

- 3.1.1 Refer to Division 15 Section "Domestic Water Piping" for piping joining materials, joint construction, and basic installation requirements.
- 3.1.2 Install balancing valves in locations where they can easily be adjusted.
- 3.1.3 Install water hammer arresters in water piping according to PDI-WH 201.
- 3.1.4 Install air vents at high points of water piping.

3.2 CONNECTIONS

- 3.2.1 Threaded or soldered joints. Refer to Division 15 Section "Domestic Water Piping" for connecting requirements.

3.3 LABELING AND IDENTIFYING

- 3.3.1.1 Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on calibrated balancing valves.

3.4 FIELD QUALITY CONTROL

- 3.4.1 Perform the following tests and prepare test reports:
- 3.4.2 Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- 3.5.1 Set field-adjustable flow set points of balancing valves.

END OF SECTION 15145

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SECTION 15150 - SANITARY WASTE AND VENT PIPING

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following for soil, waste, and vent piping inside the building:

- 1.2.1.1 Pipe, tube, and fittings.

1.3 PERFORMANCE REQUIREMENTS

- 1.3.1 Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:

- 1.3.1.1 Soil, Waste, and Vent Piping: 10-foot head of water.

1.4 SUBMITTALS

- 1.4.1 Product Data: For pipe, tube, fittings, and couplings.

- 1.4.2 Shop Drawings:

- 1.4.2.1 Sanitary Sewer and Vent System: Include plans, elevations, sections, and details.

1.5 QUALITY ASSURANCE

- 1.5.1 Piping materials shall bear label, stamp, or other markings of specified testing agency.

2 PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 2.1.1 In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

- 2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- 2.2.1 Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and

SECTION 15150 - SANITARY WASTE AND VENT PIPING

joining materials.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- 2.3.1 Pipe and Fittings: ASTM A 888 or CISPI 301.
- 2.3.2 Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 2.3.2.1 Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - 2.3.2.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
 - 2.3.2.1.1.1 Clamp-All Corp.
 - 2.3.2.1.1.2 Mission Rubber Co.
 - 2.3.2.1.1.3 Tyler Pipe; Soil Pipe Div.

2.4 COPPER TUBE AND FITTINGS

- 2.4.1 Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
 - 2.4.1.1 Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- 2.4.2 Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
- 2.4.3 Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

3 PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- 3.1.1 Aboveground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
 - 3.1.1.1 Hubless cast-iron soil pipe and fittings; heavy-duty shields, stainless-steel couplings; and hubless-coupling joints everywhere except over Operating Rooms.
 - 3.1.1.2 Copper DWV tube, copper drainage fittings, and soldered joints over Operating Rooms as indicated on the drawings.
 - 3.1.1.2.1 For Vent Piping, Over Operating Room: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

3.2 PIPING INSTALLATION

SECTION 15150 - SANITARY WASTE AND VENT PIPING

- 3.2.1 Core holes in existing concrete slabs for vertical piping extending through second floor slab.
- 3.2.2 Install cleanouts where shown and extend to building sanitary drains.
- 3.2.3 Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- 3.2.4 Install copper DWV piping according to CDA's "Copper Tube Handbook."
- 3.2.5 Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- 3.2.6 Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 3.2.6.1 Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3.2.6.2 Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- 3.2.7 Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- 3.2.8 Transition copper vent piping to cast iron once vent piping is above second floor slab. Use rubber transition manufactured for this purpose with stainless steel clamping bands.
- 3.3 JOINT CONSTRUCTION
 - 3.3.1 Basic piping joint construction requirements are specified in Division 15 Section "Common Work Requirements for Plumbing."
 - 3.3.2 Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 - 3.3.3 Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
- 3.4 HANGER AND SUPPORT INSTALLATION
 - 3.4.1 Pipe hangers and supports are specified in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

SECTION 15150 - SANITARY WASTE AND VENT PIPING

- 3.4.1.1 Vertical Piping: MSS Type 8 or Type 42, clamps.
- 3.4.1.2 Install individual, straight, horizontal piping runs using MSS Type 1, adjustable, clevis hangers:
 - 3.4.1.2.1 For cast-iron piping, use steel.
 - 3.4.1.2.2 For copper, use coated steel, or copper clevis. As an alternative, wrap piping with polyethylene tape, 5.3 mils thick minimum, two layers.
 - 3.4.1.2.3
- 3.4.2 Install supports according to Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment."
- 3.4.3 Support vertical piping and tubing at base and at each floor.
- 3.4.4 Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- 3.4.5 Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 3.4.5.1 NPS 1-1/2 and NPS 2 : 60 inches with 3/8-inch rod.
 - 3.4.5.2 NPS 3 : 60 inches with 1/2-inch rod.
 - 3.4.5.3 NPS 4 and NPS 5 : 60 inches with 5/8-inch rod.
 - 3.4.5.4 NPS 6 : 60 inches with 3/4-inch rod.
- 3.4.6 Install supports for vertical cast-iron soil piping every 15 feet .
- 3.4.7 Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 3.4.7.1 NPS 1-1/4 : 72 inches with 3/8-inch rod.
 - 3.4.7.2 NPS 1-1/2 and NPS 2 : 96 inches with 3/8-inch rod.
 - 3.4.7.3 NPS 2-1/2 : 108 inches with 1/2-inch rod.
 - 3.4.7.4 NPS 3 to NPS 5 : 10 feet with 1/2-inch rod.
- 3.4.8 Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- 3.5.1 Drawings indicate general arrangement of piping, fittings, and specialties.
- 3.5.2 Connect drainage and vent piping to the following:

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- 3.5.2.1 Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
- 3.5.2.2 Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
- 3.5.2.3 Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
- 3.5.2.4 Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection.

3.6 FIELD QUALITY CONTROL

- 3.6.1 During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 3.6.1.1 Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 3.6.1.2 Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- 3.6.2 Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- 3.6.3 Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- 3.6.4 Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 3.6.4.1 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 separate report for each test, complete with diagram of portion of piping tested.
 - 3.6.4.2 Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3.6.4.3 Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 3.6.4.4 Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug

SECTION 15150 - SANITARY WASTE AND VENT PIPING

vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg . Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- 3.6.4.5 Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 3.6.4.6 Prepare reports for tests and required corrective action.

END OF SECTION 15150

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following sanitary drainage piping specialties:

1.2.1.1 Cleanouts.

1.2.1.2 Floor drains.

1.2.1.3 Miscellaneous sanitary drainage piping specialties.

1.3 SUBMITTALS

1.3.1 Product Data:

1.3.1.1 Cleanouts.

1.3.1.2 Floor drains.

1.4 QUALITY ASSURANCE

1.4.1 Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.5 COORDINATION

1.5.1 Coordinate exact location of cleanouts with wall mounted access at third floor.
Coordinate exact location of floor drain with relocated sterilizer unit.

2 PART 2 - PRODUCTS

2.1 CLEANOUTS

2.1.1 Copper Wall Cleanouts (CO):

2.1.1.1 Basis of Design: Subject to compliance with requirements, provide NIBCO copper alloy cleanout or comparable product from another manufacturer conforming to the following:

2.1.1.1.1 JR Smith

2.1.1.1.2 JOSAM

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

- 2.1.1.2 Standard: ASTM B584. Include wall access.
- 2.1.1.3 Size: Same as connected drainage piping.
Body: DWV, soldered connection, ASTM B584 Alloy C84400.
- 2.1.1.4 Closure: Countersunk, drilled-and-threaded brass plug.
- 2.1.1.5 Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- 2.1.1.6 Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.2 FLOOR DRAINS

- 2.2.1 Cast-Iron Floor Drains (FD): ASTM D112.6.3.
 - 2.2.1.1 Pattern: Sanitary.
 - 2.2.1.2 Body Material: Gray iron.
 - 2.2.1.3 Seepage Flange: Required.
 - 2.2.1.4 Anchor Flange: Required.
 - 2.2.1.5 Coating on Interior and Exposed Exterior Surfaces: Acid-resistant enamel.
 - 2.2.1.6 Top of Body and Strainer Finish: Nickel bronze.
 - 2.2.1.7 Dimensions of Top or Strainer: 5" for two-inch drains
 - 2.2.1.8 Top Loading Classification: Medium Duty.
 - 2.2.1.9 Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet.
 - 2.2.1.10 Trap Material: Cast iron.
 - 2.2.1.11 Trap Pattern: Deep Seal P-trap

2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

- 2.3.1 Open Site Drains (OSD):
 - 2.3.1.1 Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
 - 2.3.1.2 Size: Same as connected waste piping.
- 2.3.2 Deep-Seal Traps:

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

2.3.2.1 Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.

2.3.2.2 Size: Same as connected waste piping.

2.3.2.2.1 NPS 2 : 4-inch- minimum water seal.

2.3.2.2.2 NPS 2-1/2 and Larger: 5-inch- minimum water seal.

3 PART 3 - EXECUTION

3.1 INSTALLATION

3.1.1 Refer to Division 15 Section "Sanitary Waste and Vent Piping" for piping joining materials, joint construction, and basic installation requirements.

3.1.2 Install cleanouts according to the following, unless otherwise indicated:

3.1.2.1 Size same as drainage piping.

3.1.2.2 Locate at each change in direction of piping greater than 45 degrees where shown.

3.1.3 For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

3.1.4 For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

3.1.5 Assemble open site drain fittings and install with top of hub 2 inches above floor.

3.1.6 Install deep-seal traps on open site drains.

3.1.7 Install wood-blocking reinforcement for wall-mounting-type specialties. Wood blocking must be fire treated.

3.1.8 Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.1.9 Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

3.2.1 Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.2.2 Install piping adjacent to equipment to allow service and maintenance.

3.3 PROTECTION

SECTION 15155 - SANITARY WASTE PIPING SPECIALTIES

- 3.3.1 Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- 3.3.2 Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15155

SECTION 15182 – HVAC PIPING

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

- 1.2.1.1 Hot-water heating piping.
- 1.2.1.2 High pressure (MP) steam piping.
- 1.2.1.3 Low pressure (LP) condensate piping.

1.3 DEFINITIONS

- 1.3.1 HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.
- 1.3.2 LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.
- 1.3.3 PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

- 1.4.1 Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature:
- 1.4.1.1 Hot-Water Heating Piping: 150 psig at 200 deg F.
- 1.4.1.2 High Pressure Steam Piping: 150 psig at 375 deg F.
- 1.4.1.3 Low Pressure Condensate Piping: 150 psig at 250 deg F.

1.5 SUBMITTALS

- 1.5.1 Product Data: For each type of the following:
- 1.5.1.1 Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
- 1.5.1.2 Air control devices.

SECTION 15182 – HVAC PIPING

- 1.5.1.3 Hydronic specialties.
- 1.5.2 Shop Drawings: Detail, at 1/4 scale, the piping layout.
- 1.5.3 Welding certificates.
- 1.5.4 Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.
- 1.6 QUALITY ASSURANCE
 - 1.6.1 Installer Qualifications:
 - 1.6.1.1 Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
 - 1.6.2 Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 1.6.3 Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1.6.3.1 Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 1.6.3.2 Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
 - 1.6.4 ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

2 PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- 2.1.1 Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- 2.1.2 Wrought-Copper Fittings: ASME B16.22.
- 2.1.3 Copper Unions:
 - 2.1.3.1 MSS SP-123.
 - 2.1.3.2 Cast-copper-alloy, hexagonal-stock body.
 - 2.1.3.3 Ball-and-socket, metal-to-metal seating surfaces.
 - 2.1.3.4 Solder-joint or threaded ends.
 - 2.1.3.5 Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux

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according to ASTM B813.

2.2 STEEL PIPE AND FITTINGS

- 2.2.1 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.
- 2.2.2 Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300 as indicated in Part 3 piping applications articles.
- 2.2.3 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.
- 2.2.4 Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.3 JOINING MATERIALS

- 2.3.1 Brazing Filler Metals: AWS A5.8; BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- 2.3.2 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.
- 2.3.3 Gasket Material: ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness.
 - 2.3.3.1 Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- 2.3.4 Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.4 DIELECTRIC FITTINGS

- 2.4.1 Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- 2.4.2 Insulating Material: Suitable for system fluid, pressure, and temperature.
- 2.4.3 Dielectric Unions:
 - 2.4.3.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.4.3.1.1 Capitol Manufacturing Company.
 - 2.4.3.1.2 Central Plastics Company.
 - 2.4.3.1.3 Hart Industries International, Inc.

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- 2.4.3.1.4 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- 2.4.3.1.5 Zurn Plumbing Products Group; AquaSpec Commercial Products Division.
- 2.4.3.2 Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.5 VALVES

- 2.5.1 Gate, Globe, Check, and Ball Valves: Comply with requirements specified in Division 15 Section "General-Duty Valves for HVAC Piping."
- 2.5.2 Bronze, Calibrated-Orifice, Balancing Valves:
 - 2.5.2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.5.2.1.1 Armstrong Pumps, Inc.
 - 2.5.2.1.2 Bell & Gossett Domestic Pump; a division of ITT Industries.
 - 2.5.2.1.3 Flow Design Inc.
 - 2.5.2.1.4 Griswold Controls.
 - 2.5.2.1.5 Taco.
 - 2.5.2.2 Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 2.5.2.3 Ball: Brass or stainless steel.
 - 2.5.2.4 Plug: Resin.
 - 2.5.2.5 Seat: PTFE.
 - 2.5.2.6 End Connections: Threaded or socket.
 - 2.5.2.7 Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 2.5.2.8 Handle Style: Lever, with memory stop to retain set position.
 - 2.5.2.9 CWP Rating: Minimum 125 psig.
 - 2.5.2.10 Maximum Operating Temperature: 250 deg F.

2.6 AIR CONTROL DEVICES

- 2.6.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 2.6.1.1 Amtrol, Inc.
- 2.6.1.2 Armstrong Pumps, Inc.
- 2.6.1.3 Bell & Gossett Domestic Pump; a division of ITT Industries.
- 2.6.1.4 Taco.
- 2.6.2 Automatic Air Vents:
 - 2.6.2.1 Body: Bronze or cast iron.
 - 2.6.2.2 Internal Parts: Nonferrous.
 - 2.6.2.3 Operator: Noncorrosive metal float.
 - 2.6.2.4 Inlet Connection: NPS 1/2.
 - 2.6.2.5 Discharge Connection: NPS 1/4.
 - 2.6.2.6 CWP Rating: 150 psig.
 - 2.6.2.7 Maximum Operating Temperature: 240 deg F.

2.7 HYDRONIC PIPING SPECIALTIES

- 2.7.1 Y-Pattern Strainers:
 - 2.7.1.1 Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2.7.1.2 End Connections: Threaded ends.
 - 2.7.1.3 Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 2.7.1.4 CWP Rating: 125 psig.

2.8 STEAM TRAP

- 2.8.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.8.1.1 Armstrong International, Inc.
 - 2.8.1.2 Hoffman Specialty, Division of ITT Industries.
 - 2.8.1.3 Spirax Sarco, Inc.
- 2.8.2 Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.

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- 2.8.3 Trap Type: Balanced pressure.
- 2.8.4 Bellows: Stainless steel or monel.
- 2.8.5 Head and Seat: Replaceable, hardened stainless steel.
- 2.8.6 Pressure Class: 125
- 3 PART 3 - EXECUTION
 - 3.1 PIPING APPLICATIONS
 - 3.1.1 Hot-water heating water piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
 - 3.1.2 Steam piping: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
 - 3.1.3 Condensate Piping: Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
 - 3.2 VALVE APPLICATIONS
 - 3.2.1 Install shutoff-duty isolation valves at supply connection to sterilizer, and supply and return connections at VAV box re-heat coils.
 - 3.2.2 Install calibrated-orifice, balancing valves at each branch connection to return main heating hot water piping to VAV boxes.
 - 3.3 PIPING INSTALLATIONS
 - 3.3.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of existing piping systems as made available on Record Drawings. New Work shown is based on the Record Drawings and best available information with regard to existing systems and new systems being installed. After ceilings are removed, and demolition has occurred, install piping as close as indicated. Should in-ceiling obstructions prevent piping installation as shown, route piping as necessary to provide the intended termination points. Show required deviations on shop drawings. Make needed adjustments in pipe routing at no cost to the Owner.
 - 3.3.2 Install piping in concealed locations.
 - 3.3.3 Install piping indicated to be exposed parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - 3.3.4 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - 3.3.5 Install piping to permit valve servicing.

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- 3.3.6 Install piping at indicated slopes.
- 3.3.7 Install piping free of sags and bends.
- 3.3.8 Install fittings for changes in direction and branch connections.
- 3.3.9 Install piping to allow application of insulation.
- 3.3.10 Select system components with pressure rating equal to or greater than system operating pressure.
- 3.3.11 Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- 3.3.12 Reduce pipe sizes using eccentric reducer fitting installed with level side down for steam piping.
- 3.3.13 Install branch connections to heating hot water mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe.
- 3.3.14 Install valves according to Division 15 Section "General-Duty Valves for HVAC Piping."
- 3.3.15 Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- 3.3.16 Install strainers on inlet side of VAV terminal unit.
- 3.3.17 Install drip legs prior to steam traps. Valve and cap drip leg. Bottom of capped drip leg shall be a minimum of 3" from finish floor elevation.
- 3.3.18 Identify piping as specified in Division 15 Section "Identification for HVAC Piping and Equipment."
- 3.3.19 Install escutcheon at steam piping penetrating ceiling and partitions, and condensate piping penetrating floor. Comply with requirements in Division 15 Section "Common Work Requirements for HVAC."
- 3.3.20 Install sleeve where condensate piping penetrates floor. Comply with requirements for sleeves in Division 15 Section "Common Work Requirements for HVAC." A sleeve is not required in core-drilled floors.
- 3.3.21 Coordinate and install piping devices furnished under Division 15 Section "HVAC Instrumentation and Controls." Install in locations recommended by the Controls Vendor, or in locations as directed by the Architect (Engineer).

3.4 STEAM-TRAP INSTALLATION

- 3.4.1 Provide thermostatic steam trap at condensate connection to sterilizer.
- 3.4.2 Install steam traps in accessible locations as close as possible to the sterilizer.

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3.4.3 Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full port ball valve downstream from trap unless otherwise indicated.

3.5 HANGERS AND SUPPORTS

3.5.1 Hanger, support, and anchor devices are specified in Division 15 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

3.5.2 Install the following pipe attachments:

3.5.2.1 Adjustable steel clevis hangers for individual horizontal piping.

3.5.2.2 Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

3.5.3 Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

3.5.3.1 NPS 1-1/2: Maximum span, 9 feet ; minimum rod size, 3/8 inch.

3.5.3.2 NPS 2: Maximum span, 10 feet ; minimum rod size, 3/8 inch.

3.5.4 Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

3.5.4.1 NPS 3/4: Maximum span, 5 feet ; minimum rod size, 1/4 inch.

3.5.4.2 NPS 1: Maximum span, 6 feet ; minimum rod size, 1/4 inch.

3.6 PIPE JOINT CONSTRUCTION

3.6.1 Join pipe and fittings according to the following requirements:

3.6.1.1 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

3.6.1.2 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

3.6.1.3 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.

3.6.1.4 Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

3.6.1.5 Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

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3.7 HYDRONIC SPECIALTIES INSTALLATION

3.7.1 Install manual vents at VAV terminal unit re-heat coils.

3.8 TERMINAL EQUIPMENT CONNECTIONS

3.8.1 Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

3.8.2 Install control valves in accessible locations close to connected equipment.

3.9 FIELD QUALITY CONTROL

3.9.1 Prepare HVAC piping according to ASME B31.9 and as follows:

3.9.1.1 Leave joints, including welds, un-insulated and exposed for examination during test.

3.9.1.2 Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

3.9.1.3 Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.

3.9.1.4 Set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

3.9.2 Perform the following tests on hydronic, steam, and condensate piping:

3.9.2.1 Use ambient temperature water as a testing medium.

3.9.2.2 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.

3.9.2.3 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 valve or other component in system under test.

3.9.2.4 After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks and repeat hydrostatic test until there are no leaks.

3.9.2.5 Prepare written report of testing.

3.9.3 Perform the following before operating the system:

3.9.3.1 Drain new steam piping of test water before applying steam.

3.9.3.2 Open manual valves fully.

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- 3.9.3.3 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).
- 3.9.3.4 Set temperature controls so all coils are calling for full flow.

END OF SECTION 15182

SECTION 15214 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following:

1.2.1.1 Medical air piping and specialties, designated "compressed air," operating at 50 to 55 psig for use in med.

1.2.1.2 Compressed air piping and specialties designated as "compressed air."

1.2.1.3 Owner's existing system is as manufactured by Amico, Inc.

1.2.2 Related Sections:

1.2.2.1 Division 15 Sections "Vacuum Piping for Laboratories and Healthcare Facilities" for vacuum piping and "Gas Piping for Healthcare Facilities" for medical gases, including medical air.

1.3 DEFINITIONS

1.3.1 D.I.S.S.: Diameter-index safety system.

1.3.2 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.4 SUBMITTALS

1.4.1 Product Data: For the following:

1.4.1.1 Compressed-air tubes and fittings.

1.4.1.2 Compressed-air valves and valve boxes.

1.4.1.3 Compressed-air alarm system components.

1.4.2 Shop Drawings: Diagram power, signal, and control wiring.

1.4.3 Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.

1.4.4 Qualification Data: For Installer and testing agency.

SECTION 15214 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

- 1.4.5 Non-brazing joint manufacturer certificates for installers.
- 1.4.6 Brazing certificates.
- 1.4.7 Field quality-control test reports.
- 1.5 **QUALITY ASSURANCE**
 - 1.5.1 **Installer Qualifications:**
 - 1.5.1.1 **Medical Compressed-Air Piping Systems for Healthcare Facilities:** Qualify installers according to ANSI/ASSE Standard #6010.
 - 1.5.1.2 **Non-brazing Joints for Copper Tubing:** Qualify installers according to training provided by manufacturer of specialty joining systems.
 - 1.5.2 **Testing Agency Qualifications:** An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1.5.2.1 **Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.**
 - 1.5.3 **Source Limitations:** Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 15 Section "Gas Piping for Laboratory and Healthcare Facilities."
 - 1.5.4 **Brazing:** Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
 - 1.5.5 **Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.**
- 1.6 **PROJECT CONDITIONS**
 - 1.6.1 **Interruption of Existing Compressed-Air Service:** Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1.6.1.1 **Notify Architect and Owner no fewer than five days in advance of proposed interruption of medical compressed-air service(s).**
 - 1.6.1.2 **Do not proceed with interruption of compressed-air service(s) without Owner's written permission.**
- 1.7 **COORDINATION**
 - 1.7.1 **Coordinate compressed-air service valve installation with initial system shut-down.**

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Inventory all material and equipment required for the service valve installation and verify all required is available prior to requesting system shut-down

- 1.7.2 Coordinate compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 15 Section "Vacuum Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 15 Section "Gas Piping for Laboratory and Healthcare Facilities."

2 PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- 2.1.1 Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
- 2.1.1.1 General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
- 2.1.1.2 Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
- 2.1.1.3 Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
- 2.1.2 Shape Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
- 2.1.2.1 Manufacturers: Subject to compliance with requirements, provide by one of the following:
- 2.1.2.1.1 AeroFit, Inc.
- 2.1.2.1.2 Smart Technology, Inc.
- 2.1.3 Elastic Strain Preload Fittings: Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable according to NFPA 99-5.f.10.7(4), 2005 Edition, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
- 2.1.3.1 Technology is patented to LOKRING Technology, LLC. Provide fittings from this manufacturer.

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2.2 JOINING MATERIALS

2.2.1 Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.2.2 Threaded-Joint Tape: PTFE.

2.3 VALVES

2.3.1 General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

2.3.2 Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

2.3.2.1 Pressure Rating: 300 psig minimum.

2.3.2.2 Ball: Full-port, chrome-plated brass.

2.3.2.3 Seats: PTFE or TFE.

2.3.2.4 Handle: Lever type with locking device.

2.3.2.5 Stem: Blowout proof with PTFE or TFE seal.

2.3.2.6 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

2.4 COMPRESSED-AIR PRESSURE CONTROL PANELS

2.4.1 Description: Steel box and support brackets for recessed roughing in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.

2.4.1.1 Minimum Working Pressure: 200 psig.

2.4.1.2 Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.

2.4.1.3 Pressure Gages: 0- to 300-psig range.

2.4.1.4 Before final assembly, provide temporary dust shield and U-tube for testing.

2.4.1.5 Label cover plate "Air Pressure Control."

3 PART 3 - EXECUTION

3.1 EXISTING SYSTEM

3.1.1 Existing compressed air system operates medical instrumentation and operating

SECTION 15214 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

room equipment boom brakes. System has medical compressed air quality. Piping additions shall match the existing.

3.2 PREPARATION

- 3.2.1 Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 3.2.1.1 Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 3.2.1.2 Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - 3.2.1.2.1 Scrub to ensure complete cleaning.
 - 3.2.1.2.2 Rinse with clean, hot water to remove cleaning solution.

3.3 PIPING APPLICATIONS

- 3.3.1 For new service valve installation, connect new tubing to existing tubing with elastic strain preload fittings or cryogenic memory-metal couplings.
- 3.3.2 Compressed Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints. As an alternative to brazed joints, joints in new piping may be made with elastic strain preload fittings or cryogenic memory-metal couplings.

3.4 SERVICE VALVE INSTALLATION

- 3.4.1 Install service valves in locations shown in manner to limit the medical gas system shutdown to other operating rooms to 8 hours or less. Provide required equipment, material, and manpower as required to meet the above limitation.

3.5 PIPING INSTALLATION

- 3.5.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Piping shown on plans is diagrammatic. Fully coordinate piping installation with all other Work. Ductwork and sanitary piping shall take precedence over compressed air piping.
- 3.5.2 Comply with ASSE Standard #6010 for installation of medical compressed-air piping for the compressed air piping.
- 3.5.3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

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- 3.5.4 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.
- 3.5.5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- 3.5.6 Install piping adjacent to equipment and specialties to allow service and maintenance.
- 3.5.7 Install piping with 1 percent slope downward in direction of flow.
- 3.5.8 Install special fittings and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
- 3.5.9 Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- 3.5.10 Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.
- 3.5.11 Install piping to permit valve servicing.
- 3.5.12 Install piping free of sags and bends.
- 3.5.13 Install fittings for changes in direction and branch connections.
- 3.5.14 Install compressed-air piping to compressed-air service connections.
- 3.5.15 Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.
- 3.5.16 Connect compressed-air piping to equipment requiring compressed-air service.
- 3.5.17 Install compressed-air piping devices furnished by medical boom supplier at termination of piping at medical booms.
- 3.6 **JOINT CONSTRUCTION**
 - 3.6.1 Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
 - 3.6.2 **Brazed Joints:** Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
 - 3.6.3 **Elastic Strain Preload Fittings:** Join existing copper tube to new service valve piping assemblies according to procedures developed by fitting manufacturer for installation of elastic strain preload fittings.

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- 3.6.4 Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- 3.7 COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION
 - 3.7.1 Connect new pressure sensors to existing cabling from existing alarm panels.
- 3.8 HANGER AND SUPPORT INSTALLATION
 - 3.8.1 Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
 - 3.8.2 Support horizontal piping within 12 inches of each fitting and coupling.
- 3.9 LABELING AND IDENTIFICATION
 - 3.9.1 Install identifying labels and devices for compressed-air piping systems according to Division 15 Section "Identification for Plumbing Piping and Equipment":
 - 3.9.1.1 Compressed Air: Black letters on yellow background.
- 3.10 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES
 - 3.10.1 Testing Agency: Engage a qualified testing agency to perform tests and inspections of compressed-air piping in healthcare facilities and prepare test reports.
 - 3.10.2 Tests and Inspections:
 - 3.10.2.1 Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of compressed-air piping systems concurrently with tests, inspections, and certification of medical vacuum piping and medical gas piping systems.
 - 3.10.2.2 Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - 3.10.2.2.1 Initial blowdown.
 - 3.10.2.2.2 Initial pressure test.
 - 3.10.2.2.3 Cross-connection test.
 - 3.10.2.2.4 Piping purge test.
 - 3.10.2.2.5 Standing pressure test for positive-pressure medical compressed-air piping.
 - 3.10.2.2.6 Repair leaks and retest until no leaks exist.
 - 3.10.2.3 System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020,

SECTION 15214 - COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:

- 3.10.2.3.1 Standing pressure test.
- 3.10.2.3.2 Individual-pressurization or pressure-differential cross-connection test.
- 3.10.2.3.3 Valve test.
- 3.10.2.3.4 Piping purge test.
- 3.10.2.3.5 Piping particulate test.
- 3.10.2.3.6 Final tie-in test.
- 3.10.2.3.7 Operational pressure test.
- 3.10.2.3.8 Medical air purity test.
- 3.10.2.3.9 Verify correct labeling of components.
- 3.10.2.4 Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - 3.10.2.4.1 Inspections performed.
 - 3.10.2.4.2 Procedures, materials, and gases used.
 - 3.10.2.4.3 Test methods used.
 - 3.10.2.4.4 Results of tests.
- 3.10.3 Remove and replace components that do not pass tests and inspections and retest as specified above.

END OF SECTION 15214

SECTION 15215 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 This Section includes the following:

1.2.1.1 Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 20 inches mercury.

1.2.2 Related Sections include the following:

1.2.2.1 Division 15 Sections "Compressed-Air Piping for Laboratory and Healthcare Facilities" and "Gas Piping for Healthcare Facilities."

1.2.3 Owner's existing system is as manufactured by Amico, Inc.

1.3 DEFINITIONS

1.3.1 D.I.S.S.: Diameter-index safety system.

1.3.2 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.3.3 WAGD: Waste anesthetic gas disposal.

1.3.4 Medical vacuum piping systems include medical vacuum piping systems.

1.4 SUBMITTALS

1.4.1 Product Data: For the following:

1.4.1.1 Vacuum tubes, hoses and fittings.

1.4.1.2 Vacuum valves and valve boxes.

1.4.1.3 Medical vacuum service connections.

1.4.1.4 Medical vacuum alarm system components.

1.4.2 Shop Drawings: Diagram power, signal, and control wiring.

1.4.3 Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.

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- 1.4.4 Brazing certificates.
- 1.4.5 Non-brazing joint manufacturer certificates for installers.
- 1.4.6 Field quality-control test reports.
- 1.4.7 Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.
- 1.5 **QUALITY ASSURANCE**
 - 1.5.1 Installer Qualifications:
 - 1.5.1.1 Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
 - 1.5.1.2 Non-brazing Joints for Copper Tubing: Qualify installers according to training provided by manufacturer of specialty joining systems.
 - 1.5.2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.
 - 1.5.2.1 Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
 - 1.5.3 Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 15 Section "Gas Piping for Laboratory and Healthcare Facilities."
 - 1.5.4 Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."
 - 1.5.5 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1.5.6 NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.
 - 1.5.7 Equipment: Furnish all medical vacuum components by a single manufacturer.
- 1.6 **PROJECT CONDITIONS**
 - 1.6.1 Interruption of Existing Medical Vacuum Service(s): Do not interrupt medical vacuum service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

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- 1.6.1.1 Notify Architect and Owner no fewer than five days in advance of proposed interruption of medical vacuum service(s).
- 1.6.1.2 Do not proceed with interruption of medical vacuum service(s) without Owner's written permission.
- 1.7 **COORDINATION**
 - 1.7.1 Coordinate medical vacuum service valve installation with initial system shut-down. Inventory all material and equipment required for the service valve installation and verify all required is available prior to requesting system shut-down.
 - 1.7.2 Coordinate medical vacuum service connections with other service connections. Compressed-air service connections are specified in Division 15 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 15 Section "Gas Piping for Laboratory and Healthcare Facilities."
- 2 **PART 2 - PRODUCTS**
 - 2.1 **PIPES, TUBES, AND FITTINGS**
 - 2.1.1 Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
 - 2.1.1.1 General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2.1.1.2 Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 - 2.1.1.3 Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
 - 2.1.2 Shape Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
 - 2.1.2.1 Manufacturers: Subject to compliance with requirements, provide by one of the following:
 - 2.1.2.1.1 Aerofit, Inc.
 - 2.1.2.1.2 Smart Technology, Inc.
 - 2.1.3 Elastic Strain Preload Fittings: Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable according to NFPA 99-5.f.10.7(4), 2005 Edition, and that have been manufacturer

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cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

2.1.3.1 Technology is patented to LOKRING Technology, LLC. Provide fittings from this manufacturer.

2.2 HOSE

2.2.1 Hose Assemblies: Conductive, CR, 5/16-inch- ID, medical gas hoses rated for 200-psig minimum working pressure..

2.2.2 Length: 10 feet.

2.2.3 Working pressure up to 55 psi with burst pressure rating of 200 psi at 70 deg F.

2.2.4 Color coded to conform to CGA C-9.

2.2.5 Ends with ferrules for permanently crimped connections.

2.2.6 Ceiling Outlet End: DISS female handtight nut.

2.2.7 Usable End: As required by the Owner.

2.2.8 Hose Retractor: See Division 15 Section "Gas Piping for Healthcare Facilities."

2.3 JOINING MATERIALS

2.3.1 Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus.

2.3.2 Threaded-Joint Tape: PTFE.

2.4 VALVES

2.4.1 General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

2.4.1.1 Exception: Factory cleaning and bagging are not required for valves for WAGD service.

2.4.2 Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

2.4.2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.4.2.1.1 Allied Healthcare Products, Inc.; Chemetron Div.

2.4.2.1.2 Amico, Inc.

2.4.2.1.3 BeaconMedaes.

2.4.2.2 Pressure Rating: 300 psig minimum.

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- 2.4.2.3 Ball: Full-port, chrome-plated brass.
- 2.4.2.4 Seats: PTFE or TFE.
- 2.4.2.5 Handle: Lever type with locking device.
- 2.4.2.6 Stem: Blowout proof with PTFE or TFE seal.
- 2.4.2.7 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 2.4.3 Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
- 2.4.3.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.4.3.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
 - 2.4.3.1.2 Amico, Inc.
 - 2.4.3.1.3 BeaconMedaes.
- 2.4.3.2 Pressure Rating: 300 psig minimum.
- 2.4.3.3 Ball: Full-port, chrome-plated brass.
- 2.4.3.4 Seats: PTFE or TFE.
- 2.4.3.5 Handle: Lever type with locking device.
- 2.4.3.6 Stem: Blowout proof with PTFE or TFE seal.
- 2.4.3.7 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 2.4.3.8 Vacuum Gage: Manufacturer installed on one copper-tube extension.
- 2.4.4 Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.
 - 2.4.4.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.4.4.1.1 Amico, Inc.
 - 2.4.4.1.2 Tri-Tech Medical.
 - 2.4.4.2 Interior Finish: Factory-applied white enamel.
 - 2.4.4.3 Cover Plate: Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or

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removable windows.

2.4.4.4 Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

2.4.5 Safety Valves: Bronze-body, ASME-construction, pressure-relief type with settings to match system requirements.

2.5 MEDICAL VACUUM SERVICE CONNECTIONS

2.5.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.5.1.1 Allied Healthcare Products, Inc.; Chemetron Div.

2.5.1.2 Amico Corporation.

2.5.1.3 BeaconMedaes.

2.5.2 Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

2.5.3 Finishing Assembly:

2.5.3.1 Brass housing with primary check valve.

2.5.3.2 Seals that will prevent vacuum leakage.

2.5.3.3 Cover plate with gas-service label.

2.5.4 D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

2.5.4.1 Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.

2.5.4.2 WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.

2.5.5 Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

2.5.6 Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.6 MEDICAL VACUUM PIPING ALARM SYSTEMS

2.6.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 2.6.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
- 2.6.1.2 Amico, Inc.
- 2.6.1.3 BeaconMedaes.
- 2.6.2 Panels for medical vacuum piping systems are existing and shall be re-used. See Part 3
- 2.6.3 Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices, and compatible with Owner's existing alarm system.
- 2.6.4 Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - 2.6.4.1 Vacuum Operating Range: 0- to 30-in. Hg.
 - 2.6.4.2 Include alarm signals when the following condition exists:
 - 2.6.4.2.1 Medical Vacuum: Vacuum drops below 12-in. Hg.
 - 2.6.4.2.2 WAGD: Vacuum drops below 12-in. Hg.

3 PART 3 - EXECUTION

3.1 EXISTING SYSTEM

- 3.1.1 Existing medical vacuum system is as manufactured by Amico, Inc. All equipment provided shall be compatible.

3.2 PREPARATION

- 3.2.1 Cleaning of Medical Gas Tubing: If precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
 - 3.2.1.1 Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
 - 3.2.1.2 Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - 3.2.1.2.1 Scrub to ensure complete cleaning.
 - 3.2.1.2.2 Rinse with clean, hot water to remove cleaning solution.

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3.3 PIPING APPLICATIONS

- 3.3.1 For new service valve installation, connect new tubing to existing tubing with elastic strain preload fittings or cryogenic memory-metal couplings.
- 3.3.2 Medical Vacuum Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints. As an alternative to brazed joints, joints in new piping may be made with elastic strain preload fittings or cryogenic memory-metal couplings.

3.4 SERVICE VALVE INSTALLATION

- 3.4.1 Install service valves in locations shown in manner to limit the medical vacuum system shutdown to other operating rooms to 8 hours or less. Provide required equipment, material, and manpower as required to meet the above limitation.

3.5 PIPING INSTALLATION

- 3.5.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Piping shown on plans is diagrammatic. Fully coordinate piping installation with all other Work. Ductwork and sanitary piping shall take precedence over medical vacuum piping.
- 3.5.2 Comply with ASSE Standard #6010 for installation of vacuum piping.
- 3.5.3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated.
- 3.5.4 Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- 3.5.5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
- 3.5.6 Install piping adjacent to equipment and specialties to allow service and maintenance.
- 3.5.7 Install vacuum piping with 1 percent slope downward in direction of flow.
- 3.5.8 Install special fittings and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.
- 3.5.9 Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.
- 3.5.10 Provide drain leg and drain trap at end of each main and branch and at low points.
- 3.5.11 Install piping to permit valve servicing.
- 3.5.12 Install piping free of sags and bends.

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- 3.5.13 Install fittings for changes in direction and for branch connections.
- 3.5.14 Install medical vacuum piping to medical vacuum service.
- 3.5.15 Connect vacuum piping to vacuum inlets in walls and ceiling boxes.
- 3.5.16 Install vacuum piping devices furnished by medical boom supplier at termination of piping at medical booms.
- 3.5.17 Make flexible hose connections at booms as directed by medical boom supplier.
- 3.5.18 Install ceiling mounted hose and hose retractor. See Division 15 Section "Gas Piping for Healthcare Facilities."

3.6 VALVE APPLICATIONS

- 3.6.1 Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

3.7 SERVICE VALVE INSTALLATION

- 3.7.1 Install service valves in locations shown in manner to limit the medical vacuum system shutdown to other operating rooms to 8 hours or less. Provide required equipment, material, and manpower as required to meet the above limitation.

3.8 VALVE INSTALLATION

- 3.8.1 Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
- 3.8.2 Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

3.9 JOINT CONSTRUCTION

- 3.9.1 Ream ends of pipes and tubes and remove burrs.
- 3.9.2 Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
- 3.9.3 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- 3.9.4 Braze Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.
- 3.9.5 Strain Preload Fittings: Join existing copper tube to new service valve piping assemblies according to procedures developed by fitting manufacturer for installation of elastic strain preload fittings.

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- 3.9.6 Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.
- 3.10 **MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION**
 - 3.10.1 Panel for medical vacuum piping system is existing.
 - 3.10.2 Install medical vacuum piping system alarm system components according to NFPA 99 requirements.
 - 3.10.3 Make connection between new vacuum switch/transducer using existing cabling.
- 3.11 **HANGER AND SUPPORT INSTALLATION**
 - 3.11.1 Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
 - 3.11.1.1 Support horizontal piping within 12 inches of each fitting and coupling.
- 3.12 **LABELING AND IDENTIFICATION**
 - 3.12.1 Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
 - 3.12.1.1 Medical Vacuum: Black letters on white background.
- 3.13 **FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING**
 - 3.13.1 Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.
 - 3.13.2 Tests and Inspections:
 - 3.13.2.1 Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
 - 3.13.2.2 Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
 - 3.13.2.2.1 Initial blow down.
 - 3.13.2.2.2 Initial pressure test.
 - 3.13.2.2.3 Cross-connection test.
 - 3.13.2.2.4 Piping purge test.

SECTION 15215 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

- 3.13.2.2.5 Standing pressure test for vacuum systems.
- 3.13.2.2.6 Repair leaks and retest until no leaks exist.
- 3.13.2.3 System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
 - 3.13.2.3.1 Standing pressure test.
 - 3.13.2.3.2 Individual-pressurization or pressure-differential cross-connection test.
 - 3.13.2.3.3 Valve test.
 - 3.13.2.3.4 Master and area alarm tests.
 - 3.13.2.3.5 Piping purge test.
 - 3.13.2.3.6 Final tie-in test.
 - 3.13.2.3.7 Operational vacuum test.
 - 3.13.2.3.8 Verify correct labeling of equipment and components.
- 3.13.2.4 Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - 3.13.2.4.1 Inspections performed.
 - 3.13.2.4.2 Procedures, materials, and gases used.
 - 3.13.2.4.3 Test methods used.
 - 3.13.2.4.4 Results of tests.
- 3.13.3 Remove and replace components that do not pass tests and inspections and retest as specified above.
- 3.14 DEMONSTRATION
 - 3.14.1 Train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15215

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SECTION 15216 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

1 PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes the following:
- 1.2.1.1 Carbon dioxide piping and specialties designated "medical carbon dioxide" operating at 50 to 55 psig.
 - 1.2.1.2 Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
 - 1.2.1.3 Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig.
 - 1.2.1.4 Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
 - 1.2.1.5 Medical Air piping and specialties designated "medical air" " operating at 50 to 55 psig.
- 1.2.2 Related Sections include the following:
- 1.2.2.1 Division 12 Section "Metal Medical Casework" for gas outlets in metal medical casework.
 - 1.2.2.2 Division 15 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for compressed-air piping systems for healthcare facilities.
 - 1.2.2.3 Division 15 Section "Vacuum Piping for Laboratory and Healthcare Facilities" for vacuum piping systems for healthcare facilities.
- 1.2.3 Owner's existing system is as manufactured by Amico, Inc.

1.3 DEFINITIONS

- 1.3.1 CR: Chlorosulfonated polyethylene synthetic rubber.
- 1.3.2 D.I.S.S.: Diameter-index safety system.
- 1.3.3 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- 1.3.4 Medical gas piping systems include medical carbon dioxide, medical nitrogen, medical nitrous oxide, medical air and medical oxygen nonflammable gas for healthcare facility patient care.

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1.4 SUBMITTALS

- 1.4.1 Product Data: For the following:
 - 1.4.1.1 Tubes and fittings.
 - 1.4.1.2 Valves and valve boxes.
 - 1.4.1.3 Medical gas service connections.
 - 1.4.1.4 Electrical service connections.
 - 1.4.1.5 Ceiling hose assemblies. Include integral service connections.
 - 1.4.1.6 Medical gas alarm sensors/transducers.
- 1.4.2 Shop Drawings: Diagram power, signal, and control wiring.
- 1.4.3 Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.
- 1.4.4 Qualification Data: For Installer and testing agency.
- 1.4.5 Brazing certificates.
- 1.4.6 Non-brazing joint manufacturer certificates for installers.
- 1.4.7 Field quality-control test reports.
- 1.4.8 Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- 1.5.1 Installer Qualifications:
 - 1.5.1.1 Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
 - 1.5.1.2 Non-brazing Joints for Copper Tubing: Qualify installers according to training provided by manufacturer of specialty joining systems.
- 1.5.2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1.5.2.1 Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.
- 1.5.3 Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

SECTION 15216 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

- 1.5.4 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- 1.5.5 NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.
- 1.6 PROJECT CONDITIONS
 - 1.6.1 Interruption of Existing Medical Gas Service(s): Do not interrupt medical gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1.6.1.1 Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of medical gas service(s).
 - 1.6.1.2 Do not proceed with interruption of gas service(s) without Owner's written permission.
- 1.7 COORDINATION
 - 1.7.1 Coordinate medical gas service valve installation with initial system shut-down. Inventory all material and equipment required for the service valve installation and verify all required is available prior to requesting system shut-down.
 - 1.7.2 Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Division 15 Sections "Compressed-Air Piping for Laboratory and Healthcare Facilities" and "Vacuum Piping for Laboratory and Healthcare Facilities."

2 PART 2 – PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- 2.1.1 Copper Medical Gas Tube: ASTM B 819, Type K, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.
 - 2.1.1.1 General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
 - 2.1.1.2 Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
 - 2.1.1.3 Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
 - 2.1.1.4 Shape Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.

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- 2.1.1.5 Manufacturers: Subject to compliance with requirements, provide by one of the following:
 - 2.1.1.5.1 Aerofit, Inc.
 - 2.1.1.5.2 Smart Technology, Inc.
- 2.1.2 Elastic Strain Preload Fittings: Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and when complete are permanent and non-separable according to NFPA 99-5.f.10.7(4), 2005 Edition, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
 - 2.1.2.1 Technology is patented to LOKRING Technology, LLC. Provide fittings from this manufacturer.
- 2.2 HOSE
 - 2.2.1 Hose Assemblies: Conductive, CR, 1/4- or 5/16-inch- ID, medical gas hoses rated for 200-psig minimum working pressure.
 - 2.2.2 Length: 10 feet.
 - 2.2.3 Working pressure up to 55 psi with burst pressure rating of 200 psi at 70 deg F.
 - 2.2.4 Color coded to conform to CGA C-9.
 - 2.2.5 Ends with ferrules for permanently crimped connections.
 - 2.2.6 Ceiling Outlet End: DISS female handtight nut.
 - 2.2.7 Usable End Outlet: As required by the Owner.
- 2.3 JOINING MATERIALS
 - 2.3.1 Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.
 - 2.3.2 Threaded-Joint Tape: PTFE.
- 2.4 CEILING OUTLET BOX
 - 2.4.1 General: Provide either factory fabricated or shop fabricated ceiling outlet box in accordance with the following:
 - 2.4.1.1 Basis of Design: Hospital Systems, Inc. HSI Hose/Cable Drop Ceiling Box.
 - 2.4.1.2 Welded steel construction with powder coat finish.
 - 2.4.1.3 Face Plate: 304 stainless steel with brush finish for flush mounting in the ceiling.
 - 2.4.1.4 D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

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- 2.4.1.4.1 Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.
- 2.4.1.4.2 Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
- 2.4.1.4.3 Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
- 2.4.1.4.4 Medical Oxygen Service Connections: D.I.S.S. No. 1240.
- 2.4.1.4.5 Medical Air Service Connections: D.I.S.S. No. 1160.
- 2.4.1.4.6 Medical Vacuum Hose: D.I.S.S. No. 1220 suction inlet.
- 2.4.1.4.7 WAGD Evacuation Hose: D.I.S.S. No. 2220 suction inlet.
- 2.4.1.5 Manufacturer installed (for factory fabricated) or shop installed ASTM B 819, copper-tube extensions for connection to field installed piping.
- 2.4.1.6 Hose Retractor: Permanently connected to ceiling outlet box with 48" stainless steel heavy duty cable.

2.5 VALVES

- 2.5.1 General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
- 2.5.2 Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
 - 2.5.2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.5.2.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
 - 2.5.2.1.2 Amico Corporation.
 - 2.5.2.1.3 BeaconMedaes.
 - 2.5.2.2 Pressure Rating: 300 psig minimum.
 - 2.5.2.3 Ball: Full-port, chrome-plated brass.
 - 2.5.2.4 Seats: PTFE or TFE.
 - 2.5.2.5 Handle: Lever type with locking device.
 - 2.5.2.6 Stem: Blowout proof with PTFE or TFE seal.
 - 2.5.2.7 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 2.5.3 Check Valves: In-line pattern, bronze.
 - 2.5.3.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 2.5.3.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
- 2.5.3.1.2 Amico Corporation.
- 2.5.3.1.3 BeaconMedaes.
- 2.5.3.2 Pressure Rating: 300 psig minimum.
- 2.5.3.3 Operation: Spring loaded.
- 2.5.3.4 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
- 2.5.4 Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
 - 2.5.4.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.5.4.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
 - 2.5.4.1.2 Amico Corporation.
 - 2.5.4.1.3 BeaconMedaes.
 - 2.5.4.2 Pressure Rating: 300 psig minimum.
 - 2.5.4.3 Ball: Full-port, chrome-plated brass.
 - 2.5.4.4 Seats: PTFE or TFE.
 - 2.5.4.5 Handle: Lever type with locking device.
 - 2.5.4.6 Stem: Blowout proof with PTFE or TFE seal.
 - 2.5.4.7 Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
 - 2.5.4.8 Pressure Gage: Manufacturer-installed on one copper-tube extension.
- 2.5.5 Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
 - 2.5.5.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.5.5.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
 - 2.5.5.1.2 Amico Corporation.
 - 2.5.5.1.3 BeaconMedaes.
 - 2.5.5.2 Interior Finish: Factory-applied white enamel.

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- 2.5.5.3 Cover Plate: Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.
- 2.5.5.4 Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.
- 2.5.6 Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.
- 2.5.7 Pressure Regulators: Stainless-steel body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.6 MEDICAL GAS SERVICE CONNECTIONS

- 2.6.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2.6.1.1 Allied Healthcare Products, Inc.; Chemetron Div.
 - 2.6.1.2 Amico Corporation.
 - 2.6.1.3 BeaconMedaes.
- 2.6.2 General Requirements for Medical Gas Service Connections: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
 - 2.6.2.1 Finishing Assembly:
 - 2.6.2.1.1 Brass housing with primary check valve.
 - 2.6.2.1.2 Double seals that will prevent gas leakage.
 - 2.6.2.1.3 Cover plate with gas-service label.
 - 2.6.2.2 D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
 - 2.6.2.2.1 Medical Carbon Dioxide Service Connections: D.I.S.S. No. 1080.
 - 2.6.2.2.2 Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
 - 2.6.2.2.3 Medical Nitrous Oxide Service Connections: D.I.S.S. No. 1040.
 - 2.6.2.2.4 Medical Oxygen Service Connections: D.I.S.S. No. 1240.
 - 2.6.2.2.5 Medical Air Service Connections: D.I.S.S. No. 1160.

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2.6.2.3 Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.7 MEDICAL GAS PIPING ALARM SYSTEMS

2.7.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.7.1.1 Allied Healthcare Products, Inc.; Chemetron Div.

2.7.1.2 Amico Corporation.

2.7.1.3 BeaconMedaes.

2.7.2 Panels for medical gas piping systems are existing and shall be re-used. See Part 3.

2.7.3 Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices and compatible with Owner's existing alarm system.

2.7.4 Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

2.7.4.1 Low-Pressure Operating Range: 0- to 100-psig.

2.7.4.2 High-Pressure Operating Range: Up to 250-psig.

2.7.4.3 Include alarm signals when the following conditions exist:

2.7.4.3.1 Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.

2.7.4.3.2 Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.

2.7.4.3.3 Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.

2.7.4.3.4 Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.7.4.3.5 Medical Air: Pressure drops below 40 psig or rises above 60 psig.

3 PART 3 – EXECUTION

3.1 EXISTING SYSTEM

3.1.1 Existing medical gas system is as manufactured by Amico, Inc. All equipment provided shall be compatible.

3.2 PREPARATION

3.2.1 Cleaning of Medical Gas Tubing: If precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:

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- 3.2.1.1 Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
- 3.2.1.2 Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
 - 3.2.1.2.1 Scrub to ensure complete cleaning.
 - 3.2.1.2.2 Rinse with clean, hot water to remove cleaning solution.
- 3.3 **SERVICE VALVES**
 - 3.3.1 Install service valves in locations shown in manner to limit the medical vacuum system shutdown to other operating rooms to 8 hours or less. Provide required equipment, material, and manpower as required to meet the above limitation.
- 3.4 **PIPING APPLICATIONS**
 - 3.4.1 Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.
 - 3.4.2 Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints. As an alternative to brazed joints, joints in new piping may be made with elastic strain preload fittings or cryogenic memory-metal couplings.
- 3.5 **PIPING INSTALLATION**
 - 3.5.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Piping shown on plans is diagrammatic. Fully coordinate piping installation with all other Work. Ductwork and sanitary piping shall take precedence over medical gas piping.
 - 3.5.2 Comply with ASSE Standard #6010 for installation of medical gas piping.
 - 3.5.3 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated.
 - 3.5.4 Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
 - 3.5.5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.
 - 3.5.6 Install piping adjacent to equipment and specialties to allow service and maintenance.
 - 3.5.7 Install special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.
 - 3.5.8 Install piping to permit valve servicing.

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- 3.5.9 Install piping free of sags and bends.
- 3.5.10 Install fittings for changes in direction and branch connections.
- 3.5.11 Install medical gas piping to medical gas service connections specified in this Section and to medical gas in booms.
- 3.5.12 Connect gas piping gas outlets and equipment booms. Make flexible hose connections at booms as directed by medical gas boom supplier.
- 3.5.13 Install vacuum piping devices furnished by medical boom supplier at termination of piping at medical booms.
- 3.5.14 Install ceiling mounted hose and hose retractor. See Division 15 Section "Gas Piping for Healthcare Facilities."
- 3.6 VALVE APPLICATIONS
 - 3.6.1 Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.
- 3.7 SERVICE VALVE INSTALLATION
 - 3.7.1 Install service valves in locations shown in manner to limit the medical vacuum system shutdown to other operating rooms to 8 hours or less. Provide required equipment, material, and manpower as required to meet the above limitation
- 3.8 VALVE INSTALLATION
 - 3.8.1 Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.
 - 3.8.2 Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
 - 3.8.3 Install pressure regulators on gas piping where reduced pressure is required.
- 3.9 JOINT CONSTRUCTION
 - 3.9.1 Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.
 - 3.9.2 Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.
 - 3.9.3 Strain Preload Fittings: Join existing copper tube to new service valve piping assemblies according to procedures developed by fitting manufacturer for installation of elastic strain preload fittings.
 - 3.9.4 Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

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3.10 GAS SERVICE COMPONENT INSTALLATION

- 3.10.1 Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

3.11 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

- 3.11.1 Panel for medical gas piping systems is existing.
- 3.11.2 Make connection between new medical gas pressure switch/transducer using existing cabling.

3.12 HANGER AND SUPPORT INSTALLATION

- 3.12.1 Comply with requirements in Division 15 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.
- 3.12.2 Support horizontal piping within 12 inches of each fitting and coupling.

3.13 LABELING AND IDENTIFICATION

- 3.13.1 Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
- 3.13.1.1 Carbon Dioxide: Black or white letters on gray background.
- 3.13.1.2 Nitrogen: White letters on black background.
- 3.13.1.3 Nitrous Oxide: White letters on blue background.
- 3.13.1.4 Oxygen: White letters on green background or green letters on white background.
- 3.13.1.5 Medical Air: Black letters on white background.

3.14 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

- 3.14.1 Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- 3.14.2 Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.
- 3.14.3 Tests and Inspections:
- 3.14.3.1 Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical vacuum piping systems.
- 3.14.3.2 Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

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- 3.14.3.2.1 Initial blow down.
- 3.14.3.2.2 Initial pressure test.
- 3.14.3.2.3 Cross-connection test.
- 3.14.3.2.4 Piping purge test.
- 3.14.3.2.5 Standing pressure test for positive pressure medical gas piping.
- 3.14.3.2.6 Standing pressure test for vacuum systems.
- 3.14.3.2.7 Repair leaks and retest until no leaks exist.
- 3.14.3.3 System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
 - 3.14.3.3.1 Standing pressure test.
 - 3.14.3.3.2 Individual-pressurization cross-connection test.
 - 3.14.3.3.3 Valve test.
 - 3.14.3.3.4 Master and area alarm tests.
 - 3.14.3.3.5 Piping purge test.
 - 3.14.3.3.6 Piping particulate test.
 - 3.14.3.3.7 Piping purity test.
 - 3.14.3.3.8 Final tie-in test.
 - 3.14.3.3.9 Operational pressure test.
 - 3.14.3.3.10 Medical gas concentration test.
 - 3.14.3.3.11 Medical air purity test.
 - 3.14.3.3.12 Verify correct labeling of equipment and components.
 - 3.14.3.3.13 Verify the following source equipment:
 - 1.1.1.1.1.1 Medical gas supply sources.
- 3.14.3.4 Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
 - 3.14.3.4.1 Inspections performed.
 - 3.14.3.4.2 Procedures, materials, and gases used.

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3.14.3.4.3 Test methods used.

3.14.3.4.4 Results of tests.

3.14.4 Remove and replace components that do not pass tests and inspections and retest as specified above.

3.15 DEMONSTRATION

3.15.1 Train Owner's maintenance personnel to adjust, operate, and maintain medical gas alarm system. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15216

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SECTION 15815 - METAL DUCTS

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Single-wall rectangular ducts and fittings.
- 1.2.1.2 Single-wall round and flat-oval ducts and fittings.
- 1.2.1.3 Sheet metal materials.
- 1.2.1.4 Sealants and gaskets.
- 1.2.1.5 Hangers and supports.

1.2.2 Related Sections:

- 1.2.2.1 Division 15 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
- 1.2.2.2 Division 15 Section "Testing, Adjusting, and Balancing – **REFERENCE ONLY**" for Owner's selected testing, adjusting, and balancing Agent requirements.

1.3 PERFORMANCE REQUIREMENTS

- 1.3.1 Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"

1.4 SUBMITTALS

1.4.1 Product Data: For each type of the following products:

- 1.4.1.1 Sealants and gaskets.

1.4.2 Shop Drawings:

- 1.4.2.1 Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
- 1.4.2.2 Factory- and shop-fabricated ducts and fittings.

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- 1.4.2.3 Duct layout indicating sizes, configuration, and static-pressure classes.
- 1.4.2.4 Elevation of top of ducts.
- 1.4.2.5 Dimensions of main duct runs from building grid lines.
- 1.4.2.6 Fittings.
- 1.4.2.7 Reinforcement and spacing.
- 1.4.2.8 Seam and joint construction.
- 1.4.2.9 Penetrations through fire-rated and other partitions.
- 1.4.2.10 Equipment installation based on equipment being used on Project.
- 1.4.2.11 Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
- 1.4.2.12 Hangers and supports, including methods for duct and building attachment.
- 1.4.3 Field quality-control reports.
- 1.5 **COORDINATION DRAWINGS**
 - 1.5.1 Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1.5.1.1 Duct installation, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
 - 1.5.1.2 Ceiling components.
 - 1.5.1.3 Structural members to which duct will be attached.
 - 1.5.1.4 Size and location of initial access modules for acoustical tile.
 - 1.5.1.5 Penetrations of smoke barriers and fire-rated construction.
 - 1.5.1.6 Items penetrating finished ceiling including the following:
 - 1.5.1.6.1 Lighting fixtures.
 - 1.5.1.6.2 Air outlets and inlets.
 - 1.5.1.6.3 Speakers.
 - 1.5.1.6.4 Sprinklers.

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1.5.1.6.5 Access panels.

1.6 QUALITY ASSURANCE

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

2 PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

2.1.1 General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

2.1.2 Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.1.3 Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.1.4 Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

2.2.1 General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

2.2.2 Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2.2.1 Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2.2.3 Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements,

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materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- 2.2.4 Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- 2.3.1 General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- 2.3.2 Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
- 2.3.2.1 Galvanized Coating Designation: G90.
- 2.3.2.2 Finishes for Surfaces Exposed to View: Mill phosphatized.
- 2.3.3 Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- 2.3.4 Tie Rods: Galvanized steel, 1/4-inch minimum diameter.

2.4 SEALANT AND GASKETS

- 2.4.1 General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- 2.4.2 Two-Part Tape Sealing System:
- 2.4.2.1 Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
- 2.4.2.2 Tape Width: 4 inches.
- 2.4.2.3 Sealant: Modified styrene acrylic.
- 2.4.2.4 Water resistant.
- 2.4.2.5 Mold and mildew resistant.
- 2.4.2.6 Maximum Static-Pressure Class: 10-inch wg , positive and negative.

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- 2.4.2.7 Service: Indoor and outdoor.
- 2.4.2.8 Service Temperature: Minus 40 to plus 200 deg F .
- 2.4.2.9 Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- 2.4.3 Flanged Joint Sealant: Comply with ASTM C 920.
- 2.4.3.1 General: Single-component, acid-curing, silicone, elastomeric.
- 2.4.3.2 Type: S.
- 2.4.3.3 Grade: NS.
- 2.4.3.4 Class: 25.
- 2.4.3.5 Use: O.
- 2.4.4 Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

- 2.5.1 Hanger Rods: Cadmium-plated steel rods and nuts.
- 2.5.2 Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 , "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- 2.5.3 Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- 2.5.4 Trapeze and Riser Supports:
 - 2.5.4.1 Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

3 PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- 3.1.1 Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- 3.1.2 Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

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- 3.1.3 Install ducts with fewest possible joints.
- 3.1.4 Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections. Only factory fabricated fittings are acceptable for round ducts. Saddle taps shall not be used.
- 3.1.5 Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- 3.1.6 Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- 3.1.7 Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- 3.1.8 Route ducts to avoid passing over UPS room.
- 3.1.9 Coordinate location and installation of automatic control dampers with requirements under Division 15 Section "HVAC Instrumentation and Controls."
- 3.1.10 Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
- 3.1.11 Cooperate with Owner's testing, adjusting, and balancing Agent with respect to his work.
 - 3.1.11.1 Review Division 15 Section "Testing, Adjusting, and Balancing – REFERENCE ONLY" to determine interface requirements.
 - 3.1.11.2 Be available during testing, adjusting, and balancing to assist Owner's Agent in locating balancing devices.
 - 3.1.11.3 Provide a set of sheet metal shop drawings to the Owner's Agent at his request.
- 3.2 SEAM AND JOINT SEALING
 - 3.2.1 Seal Classes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 1-2, "Standard Duct Sealing Requirements."
 - 3.2.1.1 For static-pressure classes 1- and 1/2-inch wg , comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class C.
 - 3.2.1.2 For medium-pressure systems (round duct between air handling unit and VAV terminal units) comply with MACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seal Class B.
- 3.3 HANGER AND SUPPORT INSTALLATION
 - 3.3.1 Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

SECTION 15815 - METAL DUCTS

- 3.3.2 Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- 3.3.2.1 Use powder-actuated concrete fasteners.
- 3.3.3 Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- 3.3.4 Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor.
- 3.3.5 Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- 3.4 CONNECTIONS
- 3.4.1 Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.
- 3.5 FIELD QUALITY CONTROL
- 3.5.1 Perform tests and inspections.
- 3.5.2 Duct system will be considered defective if it does not pass tests and inspections.
- 3.5.3 Prepare test and inspection reports.
- 3.6 DUCT SCHEDULE
- 3.6.1 Intermediate Reinforcement:
 - 3.6.1.1 Galvanized-Steel Ducts: Galvanized steel.
- 3.6.2 Elbow Configuration (unless shown otherwise):
 - 3.6.2.1 Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - 3.6.2.1.1 Velocity 1000 fpm or Lower:
 - 3.6.2.1.1.1 Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 3.6.2.1.2 Velocity 1000 to 1500 fpm :
 - 3.6.2.1.2.1 Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

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- 3.6.2.1.2.2 Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
- 3.6.2.1.2.3 Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- 3.6.2.1.3 Velocity 1500 fpm or Higher:
 - 3.6.2.1.3.1 Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 3.6.2.1.3.2 Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3.6.2.1.3.3 Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- 3.6.2.2 Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
 - 3.6.2.2.1 Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
- 3.6.3 Branch Configuration:
 - 3.6.3.1 Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - 3.6.3.1.1 Rectangular Main to Rectangular Branch: 45-degree entry.
 - 3.6.3.1.2 Rectangular Main to Round Branch: 45-degree entry with transition from rectangular to round.
 - 3.6.3.2 Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees."
 - 3.6.3.2.1 Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 15815

SECTION 15820 - DUCT ACCESSORIES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

1.2.1.1 Remote operated balancing dampers.

1.2.1.2 Flange connectors.

1.2.1.3 Turning vanes.

1.2.1.4 Duct-mounted access doors.

1.2.1.5 Flexible ducts.

1.3 SUBMITTALS

1.3.1 Product Data: For each type of product indicated.

1.3.2 Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1.3.2.1.1 Special fittings.

1.3.2.1.2 Manual volume damper installations.

1.3.2.1.3 Control damper installations.

1.3.2.1.4 Remote damper operators.

1.3.3 Wiring Diagrams: For power, signal, and control wiring. Source quality-control reports.

1.3.4 Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 COORDINATION DRAWINGS

1.4.1 Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

SECTION 15820 - DUCT ACCESSORIES

1.5 QUALITY ASSURANCE

- 1.5.1 Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- 1.5.2 Comply with AMCA 500-D testing for damper rating.

2 PART 2 - PRODUCTS

2.1 MATERIALS

- 2.1.1 Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- 2.1.2 Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
- 2.1.2.1 Galvanized Coating Designation: G90.
- 2.1.2.2 Exposed-Surface Finish: Mill phosphatized.
- 2.1.3 Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- 2.1.4 Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches .

2.2 REMOTE POWERED BALANCING VOLUME DAMPERS

- 2.2.1 Manufacturers: Subject to compliance with requirements, provide product from one of the following:
 - 2.2.1.1.1 Greenheck Inc.
 - 2.2.1.1.2 Pottorff; a division of PCI Industries, Inc.
 - 2.2.1.1.3 Ruskin Company.
- 2.2.2 Testing and rating conforming to AMCA 500-D.
- 2.2.3 Suitable for horizontal or vertical applications, pressure to one inch water column, 2000 fpm velocity, and 180 deg F.
- 2.2.4 Frames: Galvanized steel, 0.0396" thick round sleeve.
- 2.2.5 Blade: Galvanized steel, 0.0396" thick.

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- 2.2.6 Blade Axles: Galvanized steel, 3/8" diameter or 3/8" square.
- 2.2.7 Bearings: Molded synthetic or acetal.
- 2.2.8 Blade Seals: None.
- 2.2.9 Actuator: Manufacturer's 9-volt standard.
- 2.2.10 Accessories:
 - 2.2.10.1 Handheld balancing remote, 9-volt battery operated. Provide minimum three.
 - 2.2.10.2 Manufacturer's control cabling, in lengths required.
 - 2.2.10.3 Communications cabling junction box for RJ11 plugs.
 - 2.2.10.4 White wall plate.

2.3 FLANGE CONNECTORS

- 2.3.1 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:
 - 2.3.1.1 Ductmate Industries, Inc.
 - 2.3.1.2 Nexus PDQ; Division of Shilco Holdings Inc.
 - 2.3.1.3 Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 2.3.2 Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- 2.3.3 Material: Galvanized steel.
- 2.3.4 Gage and Shape: Match connecting ductwork.

2.4 TURNING VANES

- 2.4.1 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:
 - 2.4.1.1 Ductmate Industries, Inc.
 - 2.4.1.2 Duro Dyne Inc.
 - 2.4.1.3 METALAIRE, Inc.
 - 2.4.1.4 SEMCO Incorporated.

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- 2.4.1.5 Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 2.4.2 Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- 2.4.3 General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- 2.4.4 Vane Construction: Single wall.
- 2.5 DUCT-MOUNTED ACCESS DOORS
 - 2.5.1 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:
 - 2.5.1.1 American Warming and Ventilating; a division of Mestek, Inc.
 - 2.5.1.2 Ductmate Industries, Inc.
 - 2.5.1.3 Greenheck Fan Corporation.
 - 2.5.1.4 Nailor Industries Inc.
 - 2.5.1.5 Pottorff; a division of PCI Industries, Inc.
 - 2.5.2 Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 2.5.2.1 Door:
 - 2.5.2.1.1 Double wall, rectangular.
 - 2.5.2.1.2 Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - 2.5.2.1.3 Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - 2.5.2.1.4 Fabricate doors airtight and suitable for duct pressure class.
 - 2.5.2.2 Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 2.5.2.3 Number of Hinges and Locks:
 - 2.5.2.3.1 Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - 2.5.2.3.2 Access Doors up to 18 Inches Square: Two hinges and two sash locks.

SECTION 15820 - DUCT ACCESSORIES

2.6 FLEXIBLE DUCTS

- 2.6.1 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:
- 2.6.1.1 Flexmaster U.S.A., Inc.
- 2.6.1.2 McGill AirFlow LLC.
- 2.6.1.3 Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- 2.6.2 Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.
- 2.6.2.1 Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
- 2.6.2.2 Maximum Air Velocity: 4000 fpm .
- 2.6.2.3 Temperature Range: Minus 20 to plus 210 deg F .
- 2.6.2.4 Insulation R-value: R-6.
- 2.6.3 Flexible Duct Connectors:
- 2.6.3.1 Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches , to suit duct size.

3 PART 3 - EXECUTION

3.1 INSTALLATION

- 3.1.1 Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- 3.1.2 Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- 3.1.3 Install remote balancing dampers where indicated. Extend communications cable from damper to wall-mounted junction box. Install junction box in accordance with Division 16 requirements.
- 3.1.4 Route remote balancing damper communication cable in ceiling space in manner acceptable to the Owner.
- 3.1.5 Set dampers to fully open position before testing, adjusting, and balancing.

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- 3.1.6 Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 3.1.6.1 Upstream and downstream from turning vanes in ducts with a greater dimension of 18" and over.
 - 3.1.6.2 Control devices requiring inspection.
- 3.1.7 Install access doors with swing against duct static pressure.
- 3.1.8 Access Door Sizes: As large as duct will allow up to 18".
- 3.1.9 Label access doors according to Division 15 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- 3.1.10 Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- 3.1.11 Connect flexible ducts to metal ducts with adhesive plus draw bands.

3.2 FIELD QUALITY CONTROL

- 3.2.1 Tests and Inspections:
 - 3.2.1.1 Operate dampers to verify full range of movement.
 - 3.2.1.2 Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3.2.1.3 Inspect turning vanes for proper and secure installation.

END OF SECTION 15820

SECTION 15841 - AIR TERMINAL UNITS

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 This Section includes the following:

1.2.1.1 Shutoff single-duct air terminal units.

1.3 SUBMITTALS

1.3.1 **Product Data:** For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories. Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.

1.3.1.1 Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.

1.3.1.2 **Wiring Diagrams:** Power, signal, and control wiring.

1.3.2 **Operation and Maintenance Data:** For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1.4 QUALITY ASSURANCE

1.4.1 **Product Options:** Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

1.4.2 **Electrical Components, Devices, and Accessories:** Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4.3 **ASHRAE Compliance:** Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

1.4.4 **NFPA Compliance:** Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.4.5 **Hospital Control System Compliance:** Installation shall be compatible with the existing TRANE Tracer Summit Control System currently in-place.

SECTION 15841 - AIR TERMINAL UNITS

1.5 COORDINATION

- 1.5.1 Coordinate layout and installation of air terminal units 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.

2 PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 2.1.1 Trane Co. (The); Worldwide Applied Systems Group, single duct unit with hot water reheat and Trane Tracer Summit System Controllers or approved equal.
- 2.1.2 Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.
- 2.1.3 Casing: 0.0336-inch galvanized steel.
- 2.1.3.1 Casing Lining: 1-inch- thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive and encapsulated with 0.0217 inch thick galvanized metal liner.
- 2.1.3.2 Air Inlet: Round stub connection.
- 2.1.3.3 Air Outlet: S-slip and drive connections.
- 2.1.3.4 Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.
- 2.1.4 Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig ; and factory installed. Manufacturer's standard coil valve package is acceptable.
- 2.1.5 DDC Controls: The existing wall mounted controller shall be re-used.
- 2.1.5.1 Damper Actuator: 24 V, powered closed, spring return open.
- 2.1.5.2 Terminal Unit Controller: Controller has electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
- 2.1.5.2.1 Proportional, plus integral control of room temperature.
- 2.1.5.2.2 Time-proportional reheat-coil control.
- 2.1.5.2.3 Occupied and unoccupied operating mode.
- 2.1.5.2.4 Remote reset of airflow or temperature set points.
- 2.1.5.2.5 Adjusting and monitoring with portable terminal.

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- 2.1.5.2.6 Communication with temperature-control system specified in Division 15 Section "HVAC Instrumentation and Controls."
- 2.1.5.3 Room Sensor: Wall mounting, with temperature set-point adjustment and access for connection of portable operator terminal.
- 2.2 **SOURCE QUALITY CONTROL**
- 2.2.1 Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.
- 2.2.2 Verification of Performance: Rate air terminal units according to ARI 880.
- 3 **PART 3 - EXECUTION**
- 3.1 **INSTALLATION**
- 3.1.1 Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance. Units shall fit within the space occupied by the previously removed VAV box terminal unit.
- 3.2 **CONNECTIONS**
- 3.2.1 Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- 3.2.2 Install piping adjacent to air terminal units to allow service and maintenance.
- 3.2.3 Hot-Water Piping: In addition to requirements in Division 15 Section "HVAC Piping," connect heating coils to supply with isolation valve, strainer, control valve, and union; and to return with isolation and balancing valve and union.
- 3.2.4 Connect ducts to air terminal units according to Division 15 Section "Metal Ducts."
- 3.2.5 Make connections between VAV box terminal unit devices and existing wall mounted controller.
- 3.2.6 Provide new VAV box terminal unit control programming for Hospital's TRANE Tracer Summit System. See Division 15 Section "Sequence of Operation" for programming sequences.
- 3.3 **FIELD QUALITY CONTROL**
- 3.3.1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- 3.3.2 Perform the following field tests and inspections and prepare test reports:
- 3.3.2.1 After installing air terminal units and after electrical circuitry has been energized, test

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for compliance with requirements.

3.3.2.2 Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3.3.2.3 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.3.3 Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

3.4.1 Engage a factory-authorized service representative to perform startup service.

3.4.1.1 Complete installation and startup checks according to manufacturer's written instructions and do the following:

3.4.1.1.1 Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.

3.4.1.1.2 Verify that controls and control enclosure are accessible.

3.4.1.1.3 Verify that control connections are complete.

3.4.1.1.4 Verify that nameplate and identification tag are visible.

3.4.1.1.5 Verify that controls respond to inputs as specified.

3.5 DEMONSTRATION

3.5.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units. Refer to Division 1 Section "Contract Closeout."

END OF SECTION 15841

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

1.2.1 Section Includes:

- 1.2.1.1 Louver face diffusers.
- 1.2.1.2 Linear slot diffusers and return air grilles.
- 1.2.1.3 Fixed face grilles.

1.2.2 Related Sections:

- 1.2.2.1 Division 15 Section "Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

1.3.1 Product Data: For each type of product indicated, include the following:

- 1.3.1.1 Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
- 1.3.1.2 Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- 1.3.1.3 Coordination Drawing: For all ceiling mounted devices in the Operating Rooms. Include all elements mounting in the ceiling. Establish that required clearances are available for all in-ceiling items.

1.4 COORDINATION

- 1.4.1 Coordinate factory plenum construction with existing structural members.

2 PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

2.1.1 Louver Face Diffuser (CD-1):

- 2.1.1.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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- 2.1.1.1.1 METALAIRE, Inc.
- 2.1.1.1.2 Price Industries.
- 2.1.1.1.3 Titus.
- 2.1.1.2 Devices shall be specifically designed for variable-air-volume flows.
- 2.1.1.3 Material: Aluminum.
- 2.1.1.4 Finish: Baked enamel, white.
- 2.1.1.5 Face Size: As indicated on schedule.
- 2.1.1.6 Mounting: T-bar in 24 by 24 inch steel mounting panel.
- 2.1.1.7 Pattern: As shown on the drawings and adjustable core style.
- 2.1.1.8 Dampers: Radial opposed blade.
- 2.1.1.9 Accessories:
 - 2.1.1.9.1 Square to round neck adaptor.
- 2.2 LINEAR SLOT DIFFUSER (LD):
 - 2.2.1 Manufacturers: Subject to compliance with requirements, provide products from one of the following:
 - 2.2.1.1 METALAIRE, Inc.
 - 2.2.1.2 Price Industries.
 - 2.2.1.3 Titus.
 - 2.2.2 General: Provide linear slot diffuser designed for use in hospital operating room environment.
 - 2.2.3 Face: Two slot, fixed pattern deflectors, Type 304 stainless steel, minimum 0.037" thick, stainless steel 90 deg quick release fasteners, #4 finish, and safety cables.
 - 2.2.4 Plenum: Type 304 stainless steel, minimum 0.037" thick, continuous welded joints, chamfered corners, interior with #4 finish; with stainless steel, side mounted inlet collars in size as shown on the drawings; and opposed blade, stainless steel, face adjustable, and removable balancing dampers.
 - 2.2.5 Custom Fabrication: Factory fabricate plenums to match height restrictions imposed by structural members.
 - 2.2.6 Length: As shown on drawings and as field coordinated.

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2.2.7 Accessories:

2.2.7.1 Blank off material for section of linear slot that is not active.

2.2.7.2 End plates as necessary.

2.3 LAMINAR FLOW DIFFUSER

2.3.1 Manufacturer: Subject to compliance with requirements, provide products from one of the following:

2.3.1.1 METALAIRE, Inc.

2.3.1.2 Price Industries

2.3.1.3 Titus

2.3.2 General: Provide diffuser designed for use in hospital operating room environment.

2.3.3 Face Plate: Type 304 stainless steel, minimum 0.037" thick, ¼ turn fasteners, safety cable, and #4 finish.

2.3.4 Plenum: Type 304 stainless steel, minimum 0.037" thick, continuously welded joints, and round duct connection at top.

2.3.5 Size: 24" X 36"

2.3.6 Mounting Frame: Stainless steel for mounting in gypsum board ceiling system, with mitered and welded corners, #4 finish.

2.3.7 Balancing Damper: None.

2.4 REGISTERS AND GRILLES

2.4.1 Fixed Face Grille (RG, EG, TG):

2.4.1.1 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:

2.4.1.1.1 METALAIRE, Inc.

2.4.1.1.2 Price Industries.

2.4.1.1.3 Titus.

2.4.1.2 Material: Steel.

2.4.1.3 Finish: Baked enamel, white.

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

- 2.4.1.4 Face Arrangement: 1/2-by-1/2-by-1/2-inch grid core.
- 2.4.1.5 Core Construction: Integral Removable.
- 2.4.1.6 Frame: 1-1/4 inches wide.
- 2.4.1.7 Mounting: 24 by 24 inch sheet metal lay-in panels finished the same as the grille frame.
- 2.4.2 Operating Room Return Air Register:
 - 2.4.2.1 Manufacturer: Subject to compliance with requirements, provide products from one of the following:
 - 2.4.2.1.1 METALAIRE, Inc.
 - 2.4.2.1.2 Price Industries
 - 2.4.2.1.3 Titus
 - 2.4.2.2 General: Provide return registers designed for use in hospital operating rooms.
 - 2.4.2.3 Face: 45 deg louvers on 0.050" centers, Type 304 stainless steel, #4 finish, and 90 deg quick release stainless steel fasteners.
 - 2.4.2.4 Frame: Stainless steel wall mounting frame with mitered and welded corners and #4 finish.
 - 2.4.2.5 Volume Dampers: Opposed-blade, stainless steel construction, adjustable from the face of the register.

3 PART 3 - EXECUTION

3.1 EXAMINATION

- 3.1.1 Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- 3.1.2 Proceed with installation only after unsatisfactory conditions have been corrected.
- 3.1.3 Prior to ordering operating room diffuser plenums, field verify location of existing structural members Work of other Sections as they relate to the placement of plenums. Fully coordinate plenums with all work within the ceilings.

3.2 INSTALLATION

- 3.2.1 Install diffusers, registers, and grilles level and plumb.
- 3.2.2 Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of

SECTION 15855 - DIFFUSERS, REGISTERS, AND GRILLES

ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

3.2.3 Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.2.4 Insulate all supply air plenums in accordance with Division 15 Section "HVAC Insulation."

3.3 ADJUSTING

3.3.1 After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 15855

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SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes control equipment for HVAC systems. VAV box terminal unit controllers are existing and will be re-used. New space and duct temperature sensors are required for VAV box terminal unit control. Humidity sensors and room differential pressure sensors, with corresponding control panels are included.
- 1.2.2 The existing Hospital control system is the TRANE Tracer Summit System.
- 1.2.3 Related Sections include the following:
- 1.2.3.1 Division 15 Section "Air Terminal Units" for new VAV boxes.
- 1.2.3.2 Division 15 Section "Sequence of Operation" for requirements that relate to this Section.
- 1.2.3.3 Division 15 Section "Testing, Adjusting, and Balancing -REFERENCE ONLY" to become familiar with this work and possible required support.

1.3 DEFINITIONS

- 1.3.1 DDC: Direct digital control.
- 1.3.2 I/O: Input/output.
- 1.3.3 MS/TP: Master slave/token passing.
- 1.3.4 PC: Personal computer.
- 1.3.5 PID: Proportional plus integral plus derivative.

1.4 SYSTEM PERFORMANCE

- 1.4.1 Comply with the following performance requirements:
- 1.4.1.1 Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
- 1.4.1.2 Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.

SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

- 1.4.1.3 Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
- 1.4.1.4 Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
- 1.4.1.5 Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
- 1.4.1.6 Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - 1.4.1.6.1 Space Temperature: Plus or minus 1 deg F.
 - 1.4.1.6.2 Ducted Air Temperature: Plus or minus 1 deg F.
 - 1.4.1.6.3 Relative Humidity: Plus or minus 5 percent.
 - 1.4.1.6.4 Differential Air Pressure (Space): Plus or minus 0.01-inch wg.
 - 1.4.1.6.5 Electrical: Plus or minus 5 percent of reading.

1.5 SUBMITTALS

- 1.5.1 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.
 - 1.5.1.1 DDC System Hardware: Include technical data for interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 - 1.5.1.2 Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 - 1.5.1.3 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.
 - 1.5.1.4 Wiring Diagrams: Power, signal, and control wiring.
 - 1.5.1.5 Details of control panel faces, including controls, instruments, and labeling.
 - 1.5.1.6 Written description of sequence of operation.
 - 1.5.1.7 DDC System Hardware:
 - 1.5.1.7.1 Wiring diagrams for control units with termination numbers.

SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

- 1.5.1.7.2 Schematic diagrams and floor plans for field sensors.
- 1.5.1.7.3 Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
- 1.5.1.8 Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
- 1.5.1.9 Controlled Systems:
 - 1.5.1.9.1 Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - 1.5.1.9.2 Written description of sequence of operation including schematic diagram.
 - 1.5.1.9.3 Points list.
- 1.5.2 Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1.5.2.1 Maintenance instructions and lists of spare parts for each type of control device.
 - 1.5.2.2 Interconnection wiring diagrams with identified and numbered system components and devices.
 - 1.5.2.3 Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 1.5.2.4 Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 - 1.5.2.5 Calibration records and list of set points.
- 1.6 **QUALITY ASSURANCE**
 - 1.6.1 Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
 - 1.6.2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - 1.6.3 Comply with ASHRAE 135 for DDC system components.
- 1.7 **COORDINATION**

SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

- 1.7.1 Coordinate location of thermostats, humidistats, differential pressure sensors, and other exposed control sensors with plans and room details before installation.
 - 1.7.2 Coordinate supply of conditioned electrical branch circuits for control units.
 - 1.7.3 Coordinate equipment with Division 16 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- 2 PART 2 - PRODUCTS
- 2.1 CONTROL SYSTEM
 - 2.1.1 Manufacturers: Existing Hospital HVAC control system is the TRANE Tracer Summit System. All added hardware must be able to interface with this system.
 - 2.1.2 Control system shall consist of sensors, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
 - 2.2 PANELS
 - 2.2.1 Unitized cabinet for recessed wall mounting sized to accommodate minimum of thirty analog inputs, three for each operating room. Provide hinged, lockable cover, with manufacturer's standard finish. Enclosure shall be dustproof.
 - 2.3 DDC EQUIPMENT
 - 2.3.1 Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 - 2.3.1.1 Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 - 2.3.1.2 Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - 2.3.1.2.1 Global communications.
 - 2.3.1.2.2 Analog inputs.
 - 2.3.1.2.3 Monitoring data points.
 - 2.3.1.3 Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 - 2.3.1.4 ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
 - 2.3.2 I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

SECTION 15900 - HVAC INSTRUMENTATION AND CONTROLS

- 2.3.2.1 Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
- 2.3.3 Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 2.3.3.1 Output ripple of 5.0 mV maximum peak to peak.
 - 2.3.3.2 Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 - 2.3.3.3 Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- 2.3.4 Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 2.3.4.1 Minimum dielectric strength of 1000 V.
 - 2.3.4.2 Maximum response time of 10 nanoseconds.
 - 2.3.4.3 Minimum transverse-mode noise attenuation of 65 dB.
 - 2.3.4.4 Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- 2.4 ELECTRONIC SENSORS
 - 2.4.1 Description: Vibration and corrosion resistant; for wall or duct mounting as required.
 - 2.4.2 Thermistor Temperature Sensors and Transmitters:
 - 2.4.2.1 Accuracy: Plus or minus 0.5 deg F 0.36 deg F at calibration point.
 - 2.4.2.2 Wire: Twisted, shielded-pair cable.
 - 2.4.2.3 Insertion Elements in Ducts: Single point, 18 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft..
 - 2.4.2.4 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 2.4.2.4.1 Set-Point Adjustment: Concealed.
 - 2.4.2.4.2 Set-Point Indication: Concealed.
 - 2.4.2.4.3 Thermometer: Concealed.
 - 2.4.2.4.4 Color: Manufacturer's standard.

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- 2.4.2.4.5 Orientation: Vertical.
- 2.4.3 Humidity Sensors: Bulk polymer sensor element.
- 2.4.3.1 Accuracy: 5 percent full range with linear output.
- 2.4.3.2 Room Sensor Range: 20 to 80 percent relative humidity.
- 2.4.3.3 Room Sensor Cover Construction: Manufacturer's standard locking covers.
- 2.4.3.3.1 Set-Point Adjustment: Concealed.
- 2.4.3.3.2 Set-Point Indication: Concealed.
- 2.4.4 Pressure Transmitters/Transducers:
 - 2.4.4.1 Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - 2.4.4.1.1 Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - 2.4.4.1.2 Output: 4 to 20 mA.
 - 2.4.4.1.3 Differential Static-Pressure Range: 0- to 0.10-inch wg.
 - 2.4.4.2 Select type for measuring pressure differential between operating room and adjoining corridor.
- 2.5 STATUS SENSORS
 - 2.5.1 Electronic Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- 2.6 ACTUATORS
 - 2.6.1 Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 2.6.1.1 Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 2.6.1.2 Fail-Safe Operation: Mechanical, spring-return mechanism.
 - 2.6.1.3 Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 2.6.1.4 Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 2.6.1.5 Temperature Rating: Minus 22 to plus 122 deg F.

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2.6.1.6 Run Time: 12 seconds open, 5 seconds closed.

2.7 CONTROL VALVES

2.7.1 Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

2.7.2 Terminal Unit Control Valves: Bronze body, bronze trim, two ports as indicated, replaceable plugs and seats, and union and threaded ends.

2.7.2.1 Rating: Class 125 for service at 125 psig and 250 deg F operating conditions.

2.7.2.2 Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.

2.7.2.3 Flow Characteristics: Two-way valves shall have equal percentage characteristics.

2.8 DAMPERS

2.8.1 As provided with VAV box terminal units. See Division 15 Section "Air Terminal Units."

2.9 CONTROL CABLE

2.9.1 Electronic and fiber-optic cables for control wiring are specified in Division 16.

3 PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Verify that power supply is available to control units.

3.2 INSTALLATION

3.2.1 Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

3.2.2 Connect and configure equipment and software to achieve sequence of operation specified.

3.2.3 Reconnect all control wiring and tubing from existing VAV box controllers to new VAV box terminal units.

3.2.4 Connect new control wiring from VAV box discharge temperature sensor to existing remote located VAV box terminal unit controller.

3.2.5 Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

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- 3.2.5.1 Install room thermostats and humidistats 60 inches above the floor.
- 3.2.5.2 Install differential pressure sensors at 84 inches above the floor.
- 3.2.6 Install labels and nameplates to identify control components according to Division 15 Section "Identification for HVAC Piping and Equipment."
- 3.2.7 Coordinate installation of hydronic valves and other accessories according to Division 15 Section "Hydronic Piping."
- 3.2.8 Make connections between room humidistats and room differential pressure sensors with input panels in new surface mounted control panel.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- 3.3.1 Install raceways, boxes, and cabinets according to Division 16 requirements.
- 3.3.2 Install signal and communication cable according to Division 16 requirements.
 - 3.3.2.1 Install cable in conduit.
 - 3.3.2.2 Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - 3.3.2.3 Number-code conductors for future identification and service of control system.
 - 3.3.2.4 Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

3.4 FIELD QUALITY CONTROL

- 3.4.1 **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.
- 3.4.2 Perform the following field tests and inspections and prepare test reports:
 - 3.4.2.1 **Operational Test:** After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 3.4.2.2 Test and adjust controls and safeties.
 - 3.4.2.3 Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - 3.4.2.4 Test each point through its full operating range to verify that safety and operating control set points are as required.
 - 3.4.2.5 Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

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- 3.4.2.6 Test each system for compliance with sequence of operation.
- 3.4.2.7 Test software and hardware interlocks.
- 3.4.3 DDC Verification:
 - 3.4.3.1 Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 3.4.3.2 Check instruments for proper location and accessibility.
 - 3.4.3.3 Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 3.4.3.4 Check instrument tubing for proper fittings, slope, material, and support.
 - 3.4.3.5 Check installation of air supply for each instrument.
 - 3.4.3.6 Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 3.4.3.7 Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 3.4.3.8 Check temperature instruments and material and length of sensing elements.
 - 3.4.3.9 Check control valves. Verify that they are in correct direction.
 - 3.4.3.10 Check DDC system as follows:
 - 3.4.3.10.1 Verify that DDC controller power supply is from emergency power supply, if applicable.
 - 3.4.3.10.2 Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - 3.4.3.10.3 Verify that spare I/O capacity has been provided.
 - 3.4.3.10.4 Verify that DDC controllers are protected from power supply surges.
- 3.4.4 Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- 3.5 **ADJUSTING**
 - 3.5.1 **Calibrating and Adjusting:**
 - 3.5.1.1 Calibrate instruments.
 - 3.5.1.2 Make three-point calibration test for both linearity and accuracy for each analog

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instrument.

- 3.5.1.3 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.
- 3.5.1.4 Control System Inputs and Outputs:
 - 3.5.1.4.1 Check analog inputs at 0, 50, and 100 percent of span.
 - 3.5.1.4.2 Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - 3.5.1.4.3 Check digital inputs using jumper wire.
 - 3.5.1.4.4 Check digital outputs using ohmmeter to test for contact making or breaking.
 - 3.5.1.4.5 Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
- 3.5.1.5 Flow:
 - 3.5.1.5.1 Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
- 3.5.1.6 Pressure:
 - 3.5.1.6.1 Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - 3.5.1.6.2 Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- 3.5.1.7 Temperature:
 - 3.5.1.7.1 Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - 3.5.1.7.2 Calibrate temperature switches to make or break contacts.
- 3.5.1.8 Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- 3.5.1.9 Provide diagnostic and test instruments for calibration and adjustment of system.
- 3.5.1.10 Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- 3.5.2 Adjust initial temperature set points.

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3.5.3 Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.6 SUPPORT FOR TESTING, ADJUSTING, AND BALANCING

3.6.1 Interface with the Owner's testing, adjusting, and balancing Agent. See Division 15 Section "Testing, Adjusting, and Balancing – FOR REFERENCE ONLY."

3.6.2 Provide the necessary system documentation to allow the Agent to understand the system controls and interface points.

3.6.3 Cooperate and assist as necessary to complete the testing, adjusting, and balancing.

3.6.4 Be available to adjust set points for devices during all testing, adjusting, and balancing Agent's site work.

3.7 DEMONSTRATION

3.7.1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 1 Section "Demonstration and Training."

END OF SECTION 15900

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SECTION 15940 - SEQUENCE OF OPERATION

1 PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- 1.2.1 This Section includes control sequences for HVAC systems, subsystems, and equipment.
- 1.2.2 Related Sections include the following:
- 1.2.2.1 Division 15 Section "HVAC Instrumentation and Controls" for control equipment and devices and for submittal requirements.

1.3 DEFINITIONS

- 1.3.1 DDC: Direct digital control.
- 1.3.2 VAV: Variable air volume.

1.4 TERMINAL UNIT OPERATING SEQUENCE

- 1.4.1 VAV, Terminal Air Units with and without Hydronic Coils:
- 1.4.1.1 Room Temperature:
- 1.4.1.1.1 Input Device: Room thermostat.
- 1.4.1.1.2 Output Device: Electronic damper actuators and control-valve operators.
- 1.4.1.1.3 Action: Modulate damper and valve to maintain temperature.
- 1.4.1.1.3.1 Sequence damper from full open to minimum position, then valve (on re-heat units only) from closed to fully open.
- 1.4.1.2 VAV Box Discharge Temperature:
- 1.4.1.2.1 Input Device: Duct temperature sensor located in low-pressure ductwork down stream of VAV box.
- 1.4.1.2.2 Output Device: None. Monitoring point only.
- 1.4.1.2.3 Action: None. Monitoring point only.
- 1.4.1.3 Room Humidity:

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- 1.4.1.3.1 Input Device: Room humidistat.
- 1.4.1.3.2 Output Device: None. Monitoring point only.
- 1.4.1.3.3 Action: Display alarm at Operator's Work Station when room is occupied if humidity falls below 20% or rises above 60% for more than five minutes.
- 1.4.1.4 Room Differential Pressure:
 - 1.4.1.4.1 Input Device: Room differential pressure sensor referenced to adjacent corridor.
 - 1.4.1.4.2 Output Device: None. Monitoring point only.
 - 1.4.1.4.3 Action: Display alarm at Operator's Work Station when room is occupied if pressure in Operating Room goes negative with respect to adjacent corridor for more than one minute.
- 1.4.1.5 Operator Work Station Display: Indicate the following on operator workstation display terminal:
 - 1.4.1.5.1 Room/area served.
 - 1.4.1.5.2 Room temperature indication.
 - 1.4.1.5.3 Room temperature set point.
 - 1.4.1.5.4 Room temperature set point, occupied.
 - 1.4.1.5.5 Room temperature set point, unoccupied.
 - 1.4.1.5.6 Room relative humidity indication.
 - 1.4.1.5.7 Room relative humidity HI/LOW level alarm.
 - 1.4.1.5.8 Room differential air pressure indication with reference to corridor.
 - 1.4.1.5.9 Room differential air pressure alarm.
 - 1.4.1.5.10 Air-damper position as percent open.
 - 1.4.1.5.11 Control-valve position as percent open (on units with re-heat coils).
 - 1.4.1.5.12 VAV box discharge air temperature indication.
- 2 PART 2 - PRODUCTS (Not Applicable)
- 3 PART 3 - EXECUTION (Not Applicable)

SECTION 15940 - SEQUENCE OF OPERATION

END OF SECTION 15940

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SECTION 15950 - TESTING, ADJUSTING, AND BALANCING – REFERENCE ONLY

1 PART 1 - GENERAL

1.1 SUMMARY

1.1.1 **This Section is for reference only.** Work of this Section will be provided by the Owner under separate contract with a test and balancing Agency of his choosing. Work efforts shall be coordinated between the Owner's selected agency and work of this Contract.

1.1.2 This Section includes TAB to produce design objectives for the following:

1.1.2.1 Air Systems:

1.1.2.1.1 Variable-air-volume systems.

1.1.2.1.2 Exhaust system.

1.1.2.1.3 Isolation room exhaust systems.

1.1.2.2 Verifying that automatic control devices are functioning properly.

1.1.2.3 Reporting results of activities and procedures specified in this Section.

1.2 DEFINITIONS

1.2.1 **Adjust:** To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

1.2.2 **Balance:** To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

1.2.3 **Barrier or Boundary:** Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

1.2.4 **Draft:** A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

1.2.5 **Owner's Build-out Construction Contractor:** Contractor engaged by the Owner to build-out the fourth floor in accordance with the project construction documents issued for this purpose.

1.2.6 **Procedure:** An approach to and execution of a sequence of work operations to yield repeatable results.

1.2.7 **Report Forms:** Test data sheets for recording test data in logical order.

1.2.8 **Static Head:** The pressure due to the weight of the fluid above the point of

SECTION 15950 - TESTING, ADJUSTING, AND BALANCING – REFERENCE ONLY

measurement. In a closed system, static head is equal on both sides of the pump.

- 1.2.9 TAB: Testing, adjusting, and balancing.
- 1.2.10 Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- 1.2.11 Test: A procedure to determine quantitative performance of systems or equipment.
- 1.2.12 Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.3 SUBMITTALS

- 1.3.1 Sample Report Forms: Submit two sets of sample TAB report forms.

1.4 QUALITY ASSURANCE

- 1.4.1 TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representative(s), HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1.4.1.1 Agenda Items: Include at least the following:
 - 1.4.1.1.1 Submittal distribution requirements.
 - 1.4.1.1.2 The Contract Documents examination report.
 - 1.4.1.1.3 TAB plan.
 - 1.4.1.1.4 Work schedule and Project-site access requirements.
 - 1.4.1.1.5 Coordination and cooperation of trades and subcontractors.
 - 1.4.1.1.6 Coordination of documentation and communication flow.
 - 1.4.2 TAB Report Forms: Use standard forms from TAB firm's forms approved by Architect.
 - 1.4.3 Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."
 - 1.4.4 Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1.4.4.1 Keep an updated record of instrument calibration that indicates date of calibration

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and the name of party performing instrument calibration.

1.5 PROJECT CONDITIONS

1.5.1 Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.6 COORDINATION

1.6.1 Meet with the Engineer to establish design philosophy and expectations with respect to the Work within four weeks of notice to proceed with the Test and Balancing work.

1.6.2 Coordinate efforts with Owner's Build-out Construction Contractor with respect to has assistance to support TAB activities.

1.6.3 Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

1.6.4 Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

1.6.5 Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

2 PART 2 - PRODUCTS (Not Applicable)

3 PART 3 - EXECUTION

3.1 EXAMINATION

3.1.1 Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

3.1.1.1 Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3.1.2 Examine approved submittal data of HVAC systems and equipment.

3.1.3 Examine Project Record Documents described in Owner's Build-out Construction Contractor's Division 1 Section "Project Record Documents."

3.1.4 Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

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- 3.1.5 Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- 3.1.6 Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- 3.1.7 Examine system and equipment test reports.
- 3.1.8 Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- 3.1.9 Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
- 3.1.10 Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- 3.1.11 Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- 3.1.12 Examine strainers for clean screens and proper perforations.
- 3.1.13 Examine equipment for installation and for properly operating safety interlocks and controls.
- 3.1.14 Examine automatic temperature system components to verify the following:
 - 3.1.14.1 Dampers, valves, and other controlled devices are operated by the intended controller.
 - 3.1.14.2 Dampers and valves are in the position indicated by the controller.
 - 3.1.14.3 Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes and variable-air-volume terminals.
 - 3.1.14.4 Automatic modulating and shutoff valves, including two-way valves are properly connected.
 - 3.1.14.5 Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 3.1.14.6 Sensors are located to sense only the intended conditions.

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- 3.1.14.7 Sequence of operation for control modes is according to the Contract Documents.
- 3.1.14.8 Controller set points are set at indicated values.
- 3.1.14.9 Interlocked systems are operating.
- 3.1.14.10 Changeover from heating to cooling mode occurs according to indicated values.
- 3.1.15 Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- 3.2.1 Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 3.2.1.1 Permanent electrical power wiring is complete.
 - 3.2.1.2 Hydronic systems are filled, clean, and free of air.
 - 3.2.1.3 Automatic temperature-control systems are operational.
 - 3.2.1.4 Equipment and duct access doors are securely closed.
 - 3.2.1.5 Balance dampers are open.
 - 3.2.1.6 Isolating and balancing valves are open and control valves are operational.
 - 3.2.1.7 Ceilings are installed in critical areas where air-pattern adjustments are required and access to remote controlled balancing devices is provided.
 - 3.2.1.8 Doors can be closed so indicated conditions for system operations can be met.
 - 3.2.1.9 Obtain remote balancing damper controller from Owner as supplied by Owner's Contractor.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- 3.3.1 Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- 3.3.2 Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- 3.3.3 Mark equipment and balancing device settings with paint or other suitable,

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permanent identification material, to show final settings.

3.3.4 Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

3.4.1 **Compensating for Diversity:** When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

3.4.2 **Pressure-Independent, Variable-Air-Volume Systems:** After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

3.4.2.1 Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.

3.4.2.2 Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3.4.2.3 Measure total system airflow. Adjust to within indicated airflow.

3.4.2.4 Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.

3.4.2.5 Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.

3.4.2.5.1 If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

3.4.2.6 Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.5 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

3.5.1 Balance heating water maximum flow with balancing valve at VAV box heating coil.

3.6 TEMPERATURE-CONTROL VERIFICATION

3.6.1 Verify that controllers are calibrated and commissioned.

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- 3.6.2 Check transmitter and controller locations and note conditions that would adversely affect control functions.
- 3.6.3 Record controller settings and note variances between set points and actual measurements.
- 3.6.4 Check free travel and proper operation of control devices such as damper and valve operators.
- 3.6.5 Check the sequence of operation of control devices. Note device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.
- 3.6.6 Note operation of electric actuators using spring return for proper fail-safe operations.

3.7 TOLERANCES

- 3.7.1 Set HVAC system airflow and water flow rates within the following tolerances:
 - 3.7.1.1 Air Outlets and Inlets: 0 to minus 10 percent.
 - 3.7.1.2 Heating-Water Flow Rate: 0 to minus 10 percent.

3.8 FINAL REPORT

- 3.8.1 General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- 3.8.2 Final Report Contents: In addition to certified field report data, include the following:
 - 3.8.2.1 Field test reports prepared by system and equipment installers.
 - 3.8.2.2 Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- 3.8.3 General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - 3.8.3.1 Title page.
 - 3.8.3.2 Name and address of TAB firm.
 - 3.8.3.3 Project name.
 - 3.8.3.4 Project location.
 - 3.8.3.5 Architect's name and address.

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- 3.8.3.6 Engineer's name and address.
- 3.8.3.7 Contractor's name and address.
- 3.8.3.8 Report date.
- 3.8.3.9 Signature of TAB firm who certifies the report.
- 3.8.3.10 Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
- 3.8.3.11 Summary of contents including the following:
 - 3.8.3.11.1 Indicated versus final performance.
 - 3.8.3.11.2 Notable characteristics of systems.
 - 3.8.3.12 Nomenclature sheets for each item of equipment.
 - 3.8.3.13 Data for terminal units, including manufacturer, type size, and fittings.
 - 3.8.3.14 Notes to explain why certain final data in the body of reports varies from indicated values.
 - 3.8.3.14.1 Other system operating conditions that affect performance.
- 3.8.4 System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:
 - 3.8.4.1 Quantities of supply and return airflows.
 - 3.8.4.2 Water flow rates.
 - 3.8.4.3 Duct, outlet, and inlet sizes.
 - 3.8.4.4 Pipe and valve sizes and locations.
 - 3.8.4.5 Terminal units.
 - 3.8.4.6 Position of balancing devices.
- 3.8.5 Air-Terminal-Device Reports:
 - 3.8.5.1 Unit Data:
 - 3.8.5.1.1 System and air-handling unit identification.
 - 3.8.5.1.2 Location and zone.
 - 3.8.5.1.3 Test apparatus used.

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- 3.8.5.1.4 Area served.
- 3.8.5.1.5 Air-terminal-device make.
- 3.8.5.1.6 Air-terminal-device number from system diagram.
- 3.8.5.1.7 Air-terminal-device type and model number.
- 3.8.5.1.8 Air-terminal-device size.
- 3.8.5.1.9 Air-terminal-device effective area in sq. ft.
- 3.8.5.2 Test Data (Indicated and Actual Values):
 - 3.8.5.2.1 Airflow rate in cfm .
 - 3.8.5.2.2 Air velocity in fpm .
 - 3.8.5.2.3 Preliminary airflow rate as needed in cfm.
 - 3.8.5.2.4 Preliminary velocity as needed in fpm.
 - 3.8.5.2.5 Final airflow rate in cfm.
 - 3.8.5.2.6 Final velocity in fpm.
 - 3.8.5.2.7 Space temperature in deg F.
 - 3.8.5.2.8 Space relative humidity.
 - 3.8.5.2.9 Space differential pressure with respect to reference corridor.
- 3.8.6 System-Coil Reports: For reheat coils of terminal units, include the following:
 - 3.8.6.1 Unit Data:
 - 3.8.6.1.1 System and air-handling unit identification.
 - 3.8.6.1.2 Location and zone.
 - 3.8.6.1.3 Room served.
 - 3.8.6.1.4 Coil make and size.
 - 3.8.6.2 Test Data (Indicated and Actual Values):
 - 3.8.6.2.1 Airflow rate in cfm.
 - 3.8.6.2.2 Entering-water temperature in deg F.

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- 3.8.6.2.3 Leaving-water temperature in deg F.
- 3.8.6.2.4 Water pressure drop in feet of head or psig.
- 3.8.6.2.5 Entering-air temperature in deg F.
- 3.8.6.2.6 Leaving-air temperature in deg F.
- 3.8.7 Instrument Calibration Reports:
 - 3.8.7.1 Report Data:
 - 3.8.7.1.1 Instrument type and make.
 - 3.8.7.1.2 Serial number.
 - 3.8.7.1.3 Application.
 - 3.8.7.1.4 Dates of use.
 - 3.8.7.1.5 Dates of calibration.
- 3.9 INSPECTIONS
 - 3.9.1.1.1 Initial Inspection:
 - 3.9.1.1.1.1 After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - 3.9.1.1.1.2 Randomly check the following for each system:
 - 3.9.1.1.1.2.1 Measure airflow of at least 10 percent of air outlets.
 - 3.9.1.1.1.2.2 Measure water flow of at least 5 percent of terminals.
 - 3.9.1.1.1.2.3 Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - 3.9.1.1.1.2.4 Measure sound levels at two locations.
 - 3.9.1.1.1.2.5 Measure space pressure of at least 10 percent of locations.
 - 3.9.1.1.1.2.6 Verify that balancing devices are marked with final balance position.
 - 3.9.1.1.1.2.7 Note deviations to the Contract Documents in the Final Report.
- 3.10 FINAL INSPECTION
 - 3.10.1 After initial inspection is complete and evidence by random checks verifies that

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testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.

- 3.10.2 TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
- 3.10.3 Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
- 3.10.4 If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
- 3.10.5 If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- 3.10.6 TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
- 3.10.7 Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.
- 3.11 ADDITIONAL TESTS
- 3.11.1 Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- 3.11.2 Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 15950

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