SECTION 230500 - BASIC HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work under this Section shall comply with the requirements of General Conditions, Supplemental Conditions, Special Conditions and Division 01 - General Requirements, and shall include all Mechanical Sections specified herein.

1.2 SCOPE OF THIS SECTION

A. All work to be furnished and installed under this Section shall comply with all the requirements of Division 01, and shall include, but not necessarily be limited to, the following:

1. Compliance with all codes and standards applicable to this jurisdiction
2. Shop Drawings for Equipment
3. Coordination Documents
4. Record Drawings
5. Start-up Service and Building Commissioning
6. Instruction, Maintenance, and O & M Manuals
7. Work associated with Delivery, Storage, and Handling of products
8. Preparation of Posted Operating Instructions
9. Meeting Project Safety and Indemnity requirements
10. Proper Cleaning and Closing
11. Supplying proper Warranty information
12. Supply specified Guarantee documentation
13. Design and provision of Supports and Anchors
14. Pipe Portals
15. Pipe Supports
16. Equipment Rails
17. Access Doors
18. Identification Markers
19. Coordination of Electrical requirements for equipment provided

1.3 DESCRIPTION OF WORK

A. This project includes a fourth floor, ~13,200 SF TI for the PSU Speech and Hearing Department. An existing dual duct system served from an AHU in the penthouse, shall be utilized to provide conditioning and ventilation to this floor. One existing split system serving the electrical room shall be reused. New dual duct terminal units will be provided to align with the new programming. The existing dual duct terminal units serving the level above shall be reused as possible.

B. The Contract Documents, including Specifications, Construction Drawings, Owner Design Requirements and referenced Codes and Standards, require the Contractor to provide all material and labor to install complete and operable heating, ventilating, air conditioning systems for the project, whether or not specifically shown in the

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documents, and where applicable, shall appropriately interface with all existing building systems affected by new construction.

C. The Contractor shall refer to the architectural interior details, floor plans, elevations, and the structural and other Contract Drawings and shall coordinate this work with that of the other trades to avoid interference.

D. The drawings are diagrammatic and show generally the locations of the fixtures, equipment, duct routing and pipe routing and are not to be scaled. All dimensions and existing conditions shall be inspected and verified by contractors at the building prior to start of any work.

E. The Contractor shall comply with the project closeout requirements as detailed in General Requirements of Division 01.

F. Where project involves interface with existing building and site systems, every effort has been made to note existing utilities and services. However, the Contractor should thoroughly familiarize themselves with existing conditions and be aware that in some cases information is not available as to concealed conditions, which exist in portions of the existing building affected by this work.

G. The contractor shall design and supply all miscellaneous metals and system support components that are necessary to support all mechanical system, whether indicated or not on the drawings. Such metals and support components and related connections shall be provided as necessary to directly and concentrically impost loads on the primary structure. Refer to structural design requirements for specific attachment requirements. The mechanical system supports shall accommodate lateral movements between floors as defined in the story drift requirements.

H. The contractor shall design and supply mechanical devices and system components that are necessary to accommodate structural movement as defined by structural design criteria associated with ductwork and piping transitions through building expansion joints. Design of expansion joints to allow for dimensional changes in portions of a structure separated by such joints should take both reversible and irreversible movements into account.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications:

1. Specifications, in general, describe quality and character of materials and equipment.
2. Specifications are of simplified form and include incomplete sentences.

B. Drawings:

1. Drawings in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation. Coordinate with other trades before commencing any work.
2. Before proceeding with work check and verify all existing and new dimensions. Verify exact location and elevation of existing work prior to any construction.
3. Contractor shall assume all responsibility for fitting of materials and equipment to other parts of equipment and structure, and to avoid other pipes, conduits and

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ducts. Contractor shall be responsible to relocate other work or modify new work as necessary.

4. Contractor shall make adjustments that may be necessary or requested, in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.
5. If any part of Specifications or Drawings appears unclear or contradictory, apply to Owner's Representative interpretation and decision as early as possible, including during bidding period.

1.5 DEFINITIONS

A. Above Grade: Not buried in the ground and not embedded in concrete slab on ground.

B. Accessible: Ability to perform recommended maintenance without removal of services or equipment and requiring no special platforms.

C. Actuating or Control Devices: Automatic sensing and switching devices such as thermostats, pressure, float, electro-pneumatic switches and electrodes controlling operation of equipment.

D. Below Grade: Buried in the ground or embedded in concrete slab on ground.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces, or in enclosures. In general, any item not visible or directly accessible.

F. Connect: Complete hook-up of item with required service.

G. Drift: The horizontal deflection at the top of the story relative to the bottom of the story. Refer to structural design for drift dimensional movements.

H. Embodied Carbon: The embodied carbon of a product is the total amount of Greenhouse Gas Emissions (GHG) associated with the whole life cycle of the product, including raw material extraction, manufacturing, transportation, installation, maintenance, and end-of-life disposal.

I. Environmental Product Declaration (EPDs): A standardized report quantifying the environmental impact of a product or system. Declarations include information on the environmental impact of raw material acquisition, energy use and efficiency, content of materials and chemical substances, and emissions related to air, soil, and water. Product and company information is also included. An acceptable EPD shall meet the environmental requirements of ISO 14021-1999, ISO 14025-2006 and EN 15804, or ISO 21930-2007.

1. Industry-Wide EPD: Based on multiple manufacturers of a common product type.
2. Product Specific EPD: Based on a product by single manufacturer but may include average of multiple facilities making the same product.
3. Product Specific, Facility Specific EPD: Based on product by single manufacturer from single facility.

J. Explosion Proof Equipment (per National Electrical Code-Article 501): Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or

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vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. Explosion proof motors are required for Class I, II or II applications regardless of Division or Group as defined in National Electrical Code – Article 501 and ANSI/ISA-12.20.01.

1. Class I: Hazardous due to flammable gases or vapors are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
2. Class II: Hazardous due to combustible or conductive dusts are present or may be present in quantities sufficient to produce explosive or ignitable mixture.
3. Class III: Hazardous dues to ignitable fibers are present or may be present in quantities sufficient to produce explosive or ignitable mixtures.
4. Division: The substance referred to by Class has a high probability (Division 1) or low probability (Division 2) of producing an explosive or ignitable mixture due to it being present continuously, intermittently, or periodically or from the equipment itself under normal operating conditions.
5. Group: Type of hazardous material in surrounding environment ranging from Group A flammable liquids to Group G combustible dusts.

K. Exposed: Not installed underground or concealed.

L. FRT: Fire retardant treated wood is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less.

M. Furnish: To supply equipment and products as specified.

N. Indicated, Shown or Noted: As indicated, shown or noted on Drawings or Specifications.

O. Install: To erect, mount and connect complete with related accessories.

P. Motor Controllers: Manual or magnetic starters (with or without switches), individual push buttons or hand-off-automatic (HOA) switches controlling the operation of motors.

Q. Must: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall.

R. Noncombustible Material: A noncombustible material is a substance that will not ignite, burn, support combustion, or release flammable vapors when subject to fire or heat in compliance with ASTM E136 Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C. Examples of noncombustible materials include the following, but confirm compliance in manufacturer literature:

1. Portland cement concrete, concrete, gypsum concrete (normally used in drywall or poured gypsum floor toppings), Portland cement stucco, Portland cement plaster, and gypsum plaster, gypsum wall board (sheetrock), and Type X gypsum wall board.
2. Brick masonry, concrete block masonry, and ceramic tiles.

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3. Steel, stainless steel, galvanized steel, and other metals, except aluminum (aluminum is classified as limited-combustible), magnesium and magnesium alloys.
4. Sheet glass, block glass, and uncoated glass fibers.
5. Mineral wool and rock wool.

S. NRTL: Nationally Recognized Testing Laboratory, including UL and/or ETL.

T. Piping: Pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and related items.

U. Provide: To supply, install and connect as specified for a complete, safe and operationally ready system.

V. Reviewed, Satisfactory or Directed: As reviewed, satisfactory, or directed by or to Architect/Engineer/Owner's Representative.

W. Rough-In: Provide all indicated services in the necessary arrangement suitable for making final connections to fixture or equipment.

X. Shall: An exhortation or command to complete the specified task including providing and installing work associated with task.

Y. Similar or Equal: Of base bid manufacture, equal in materials, weight, size, design, and efficiency of specified products.

Z. Supply: To purchase, procure, acquire and deliver complete with related accessories.

AA. Typical or Typ: Exhibiting the qualities, traits, or characteristics that identify a kind, class, number, group or category. Of or relating to a representative specimen. Application shall apply to all other similarly identified on plan or detail.

BB. Will: A desire to complete the specified task. Allows some flexibility in application as opposed to Shall".

CC. Wiring: Raceway, fittings, wire, boxes and related items.

DD. Work: Labor, materials, equipment, apparatus, controls, accessories, and other items required for proper and complete installation.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. All Division 23 Mechanical sections included herein.

B. Division 33: Utility Site Work.

1. Coordination of excavation of trenches and the installation of mechanical systems and piping on site.

C. Division 03: Concrete.

1. All concrete work required for mechanical work shall be provided by Division 03 installer. Division 23 installer shall coordinate with Division 03 installer for all locations, including, but not limited to, the following locations:

a. Concrete curbs and housekeeping pads for the mechanical equipment.
b. Thrust blocks, pads, and boxes for mechanical equipment.

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D. Division 07: Thermal and Moisture Protection.

1. All caulking and sealing work required for mechanical work shall be provided by Division 07 installer. Division 23 installer shall coordinate with Division 07 installer for all locations, including, but not limited to, the following:

a. Flashing and sheet metal.
b. Sealants and caulking.
c. Firestopping at all rated penetrations.

E. Division 09: Painting.

1. All painting work required for mechanical work shall be provided by Division 09 installer. Division 23 installer shall coordinate with Division 09 installer, except where specifically stated otherwise in Division 09 the installer shall paint the following systems:

a. Painting of all exposed steel, piping, ductwork, insulation, equipment and materials
b. Paint all exposed gas piping, interior and exterior to the building, and a required by Authority Having Jurisdiction, yellow color if not stated elsewhere in Architectural design.

F. Division 10: Miscellaneous Metals.

1. All exterior louvers and grilles required for mechanical work shall be coordinated by Division 23 installer with Division 10 installer. Division 23 installer shall provide all louvers and grilles for installation by Division 09 installer except where specifically stated otherwise in Architectural design or Mechanical drawings.

G. Division 22: Plumbing

1. Controls interface of plumbing equipment.

H. Division 26: Electrical.

1. Power connections to all mechanical equipment and controls interface of electrical equipment.

I. Division 28: Electronic Safety and Security.

1. Fire protection alarms and relays.
2. Smoke detector and monitoring.
3. Life safety systems.

1.7 CODES AND STANDARDS

A. The Contractor is cautioned that code requirements not explicitly detailed in these specifications or drawings, but which may be reasonably inferred or implied from the nature of the project, must be provided as part of the contract.

B. Perform all tests required by governing authorities and required under all Division 23 Sections. Provide written reports on all tests.

C. Electrical devices and wiring shall conform to the latest standards of NEC; all devices shall be UL listed and labeled.

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D. All accessible mechanical work shall comply with the minimum requirements of the Americans with Disabilities Act (ADA) and local amendments. Also, refer to ICC/ANSI A117.1 Accessible and Usable Buildings and Facilities. Refer to Architectural drawings and specifications for additional ADA requirements. The following requirements are provided as consolidated list of minimum ADA requirements. Compliance requirements applicable to HVAC work includes, but is not limited to, the following:

1. Section 309: Operable parts shall be operable with one hand and shall not require tight grasping, pinching, or twisting of the wrist. The force required to activate operable parts shall be 5 pounds maximum.
2. Section 308.3: Temperature control devices mounted on walls with operable buttons or switches shall be placed where clear floor or ground space allows a parallel approach and the side reach is unobstructed. Operable parts shall be located 48” maximum above finished floor, and no lower than 42” above finished floor. Do not mount above light switches to avoid inaccurate temperature readings due to light switch heat output.
3. Section 308.3.2: Where a clear floor or ground space allows a parallel approach to an element and high reach is over an obstruction, the height of the obstruction shall be 34” maximum and depth of obstruction shall be 24” maximum.
4. Section 404.2.9: Fire doors shall have a minimum opening force allowable by the applicable Building Code. The force for pushing or pulling open a door other than fire doors shall be 5 pounds maximum.

E. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.

F. Provide in accordance with rules and regulations of the following:

1. Oregon Building Codes enforced by the Authority Having Jurisdiction (AHJ):
    a. 2025 Oregon Structural Specialty Code (OSSC) based on 2024 International Building Code (IBC).
    b. 2025 Oregon Energy Efficiency Specialty Code (OEESC) based on the ASHRAE Standard 90.1-2012.
    c. 2025 Oregon Mechanical Specialty Code (OMSC) based on the 2024 International Mechanical Code (IMC) and the 2024 International Fuel Gas Code (IFGC) with State Amendments.
    d. 2023 Oregon Plumbing Specialty Code (OPSC) based on the 2021 Uniform Plumbing Code (UPC).
    e. 2025 Oregon Fire Code (Based on the 2024 International Fire Code.)
2. Local, city, county and state codes and ordinances.
3. Local Bureau of Buildings.
4. Local Health Department.
5. Local and State Fire Prevention Districts.
6. State Administrative Codes.

G. Provide in accordance with appropriate referenced standards of the following and as referenced in other specification sections:

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1. AABC - Associated Air Balance Council
2. ADA - Americans with Disabilities Act
3. ADC - Air Diffuser Council
4. AHRI - Air Conditioning, Heating and Refrigeration Institute
5. AMCA - Air Moving and Conditioning Association
6. ANSI - American National Standards Institute
7. ASCE 7-10 – American Society of Civil Engineers – Minimum Design Loads for Buildings and Other Structures
8. ASHRAE - American Society of Heating, Refrigerating & Air Conditioning Engineers
9. ASME - American Society of Mechanical Engineers
10. ASTM - American Society for Testing Materials
11. AWS - American Welding Society
12. CIBSE TM65 _ 2021 – Chartered Institution of Building Services Engineers Technical Memorandum 65, Embodied Carbon in Building Services: A Calculation Methodology
13. CSA - Canadian Standards Association
14. ETL - Electrical Testing Laboratories
15. FM - Factory Mutual
16. IBC - International Building Code
17. ICC AC156 Seismic Certification by Shake-Table Testing of Nonstructural Components.
18. MSS - Manufacturer's Standardization Society
19. NEMA - National Electrical Manufacturer's Association
20. NFPA - National Fire Protection Association
21. SMACNA - Sheet Metal and Air Conditioning Contractors National Association
22. UL - Underwriter's Laboratories

H. Provide compliance in accordance with the following referenced standard which applies to general system compliance in contrast to specific equipment standards referenced elsewhere:

1. UL-2043: Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces. This is applicable to spaces above suspended ceilings and below raised floors.

1.8 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to the Owner’s Representative for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values

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are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Owner's Representative for a decision before proceeding.

1.9 QUALITY ASSURANCE

A. Manufacturer's Nameplates: Nameplates on manufactured items shall be metallic riveted or bolted to the manufactured item, with nameplate data engraved or punched to form a non-erasable record of equipment data suitable for the ambient exposure.

B. All work shall include the following:

1. Manufactured items and equipment shall be a current, cataloged product of the manufacturer.
2. Replacement parts shall be readily available and stocked in the USA.

C. Experience: Unless more stringent requirements are specified in other sections of Division 23, manufactured items shall have been installed and used, without modification, renovation or repair, on other projects for not less than one year prior to the date of bidding for this project.

D. Each product and/or equipment type shall be provided by one manufacturer. Mixtures of manufacturers for each product and/or equipment type are not acceptable. Example – all fire dampers shall be supplied by one manufacturer.

E. Special Inspections: Provide structural design and Special Inspections as required in Chapter 17 of the local building code and the Authority Having Jurisdiction, and as defined in the manufacturer installation instructions for each anchorage system. All anchors post-installed in hardened concrete members shall have periodic Special Inspections. Special inspection agencies shall be independent of the design and construction companies and shall act as agents for the AHJ, but contracted directly with the Owner or Owner's Representative.

F. Welding Standards:

1. Welding Qualifications:

a. Certification: Each welder shall have a current AWS QC7 welding certification with successful completion of written test and welding samples in compliance with AWS D1.1. The welder must maintain their certification to show qualified welding experience every six months. The Owner's Representative reserves the right to request sample coupon test welds of each welder to validate quality of welding work.

2. Welding Procedures:

a. Steel Support Welding: All work shall be performed in compliance with American Welding Society AWS D1.1/D1.1M-Structural Welding Code-Steel.
b. Pipe Welding: All work shall be performed to meet or exceed the requirements of the American Welding Society AWS B2.1 Specification for Welding Procedure and Performance Qualification and ASME Boiler & Pressure Vessel Code: Section IX "Qualification Standard for Welding and

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Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators."

G. Pressure Piping Standards

1. Comply with ASME B31.1 Power Piping, ASME B31.3-Process Piping and ASME B31.9-Building Services Piping standards for materials, products, and installation per pressure and temperature operating class.
2. Comply with ASME B31.9 Building Services Piping standard for the following services:

a. Conveying fluid between 0°F (-18°C) to 250°F (121°C).
b. Fluid pressure less than 350 psig.

1.10 GENERAL REQUIREMENTS

A. Examine all existing conditions at building site.

B. Review contract documents and technical specifications for extent of new work to be provided.

C. Provide and pay for all permit, licenses, fees and inspections, including, but not limited to, building permits, planning permits, air quality management district permits, operating licenses, utility district fees, special district fees, environmental impact reports, and additional local permits and fees.

D. Prepare a Construction IAQ Management Plan meeting the SMACNA IAQ guidelines. See Section 233113 Air Distribution for a summary of requirements.

E. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing. This work shall include furnishing and installing all access doors required for mechanical access. Joints and fittings shall not be located in inaccessible locations such wall, floor and roof penetrations.

F. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Refer to Equipment Specifications for rough-in requirements.

G. Coordinate mechanical equipment and materials installation with other building components.

H. Ductwork and piping dimensions, as identified on drawings and in specifications, refer to the interior free dimensions. Adjust work as necessary to account for larger outside dimensions to account for material wall thickness. Upsize plastic pipe diameters as necessary to maintain minimum interior dimensions.

I. Verify all dimensions by field measurements.

J. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.

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K. 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.

L. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

M. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials. Contractor shall provide for all cutting and patching required for installation of this work unless otherwise noted.

N. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.

O. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, without interference with other installations.

P. Coordinate the installation of mechanical materials and equipment above ceilings with ductwork, piping, conduits, suspension system, light fixtures, cable trays, sprinkler piping and heads, and other installations.

Q. Coordinate with Owner's Representative in advance to schedule shutdown of existing systems to make new connections. Provide valves in new piping to allow existing system to be put back in service with minimum down time.

R. All materials (such as supports, gaskets, sealants, insulation, ductwork, piping, wiring, controls, etc.) located within air plenum spaces, air shafts, and occupied spaces shall be noncombustible or have a flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) Method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified. Coordinate with all disciplines to assure that all discrete electrical, plumbing and mechanical products located in plenums are non-combustible and compliant with UL 2043

S. Products made of or containing lead, asbestos, mercury or other known toxic or hazardous materials are not acceptable for installation under this Division. Any such products installed as part of the work of the Division shall be removed and replaced and all costs for removal and replacement shall be borne solely by the installing Contractor.

1.11 CYBERSECURITY PROTECTION

A. For all installed systems that have internet connectivity, including but not limited to controls, monitoring, metering, sensors, or other remote access capabilities, the General Contractor is responsible to request from its subcontractors a cybersecurity risk mitigation plan. All cybersecurity risk mitigation plans shall be coordinated with the owner to verify functionality and compatibility with the owner's network architecture and topology. Cybersecurity risks to be mitigated include intrusion, remote access, viruses, spy-ware, and malware. Put in-place and in-use effective protection and homogenous

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policies for infrastructure, servers, workstations, controllers, network connected equipment, internet connected systems/devices, WiFi devices, IOT devices and mobile devices. Where relevant and applicable, apply the requirements of ISO/IEC 27000 Series of Standards relating to “Information Technology - Security Techniques”.

B. For any “highly secure environments” identified by the owner, implement relevant jurisdiction-specific standards to be performed by an accredited Information Security advisor.

C. Coordinate with Division 27 and 28 work as applicable.

1.12 MINOR DEVIATIONS

A. The Drawings are diagrammatic and show the general arrangements of all mechanical work and requirements to be performed. It is not intended to show or indicate all offsets, fittings, and accessories which will be required as a part of the work of this Section.

B. The Contractor shall review the structural and architectural conditions affecting their work. It is the specific intention of this section that the contractor's scope of work shall include:

1. Proper code complying support systems for all equipment whether or not scheduled or detailed on drawings or in these specifications
2. Minor deviations from the mechanical plans required by architectural and structural coordination.

C. The Contractor shall study the operational requirements of each system, and shall arrange work accordingly, and shall furnish such fittings, offsets, supports, accessories, as are required for the complete, proper and efficient installation of all systems from the physical space available for use by this section. This requirement extends to the Contractor's coordination of this section's work with the “Electrical Work”, “Plumbing Work” and all work associated with deferred and delegated design and construction scopes. Should conflicts occur due to lack of coordination, the time delay, cost of rectification, demolition, labor and materials, shall be borne by the Contractor and shall not be at a cost to the Owner.

D. Minor deviations to avoid conflict shall be permitted where neither the design intent nor system performance is altered.

E. Advise the Owner’s Representative, in writing, in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner’s Representative of conflict.

1.13 MAJOR DEVIATIONS

A. Major deviation is a deviation from the project design that is not a minor deviation. This includes but is not limited to changes to the design intent, system or equipment capacities and/or energy performance, system or equipment performance, utility routing, equipment room layouts, equipment orientations that may affect other trades, and weights that differ from the scheduled values.

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B. In addition to all Division 01 and Division 23 requirements associated with Substitution requests, Contractor shall give Engineer specific written notice of any major deviations that the Submittal may have from the requirements of the Contract Documents with each Submittal or Shop Drawing. This notice must be set forth in a written communication prepared on the contractor's letterhead separate from the Submittal; and, in addition, in the case of a Shop Drawing or Product Submittal, by a specific notation made on the Shop Drawing or Product Submittal itself. The Contractor shall clearly indicate proposed deviations from requirements in the Contract Documents, including variations, limitations, cost impacts and additional engineering design that may be required. Include relevant additional information and revisions, other than those requested by Engineer on previous submittals. Include the same identification information as related to the associated submittal.

1.14 SPECIFIED EQUIPMENT

A. Where specific manufacturers and/or model numbers are provided in the contract documents, it shall be understood that they constitute the design basis for the project. Where approved optional manufacturers are identified, the Contractor may submit based on these manufacturers, however, the submittals must be inclusive of all additional costs (or credits) and coordination requirements necessary to successfully and fully implement said manufacturer's product. See section on Substitutions below for procedures to use non-specified equipment.

B. **Where required by law**, specified equipment listed on the contract documents shall be interpreted to include the phrase "or equal" to allow products that are equal to those specified. The Engineer of Record has the sole authority to accept a product as equal to the specified product. For an "or equal" product to be accepted for use on the project, the following conditions must be met:

1. The proposed "or equal" substitution shall be submitted within seven days (7) of contract award.
2. Contractor shall notify the Engineer as to how the substituted product will impact the project completion.
3. Contractor shall notify Engineer as to the costs of both the substituted product and the listed product.
4. Contractor shall provide a detailed analysis of the difference between the listed product and proposed product.
5. Contractor shall provide:
    a. Product identification, manufacturer literature, samples, names and addresses of similar projects where the substituted product has been used along with facility contact information, and
    b. The name and address of the manufacturer's representative
6. Contractor shall pay the cost of the design team to review the proposed substitution and any redesign fees.

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C. Engineer's approval of an “or equal” product does not relieve Contractor of the responsibility to submit required shop drawings and to comply with all other requirements of the Contract Documents.

1.15 SHOP DRAWINGS AND EQUIPMENT SUBMITTALS

A. Prior to construction submit for review all materials and equipment in accordance with this section and Division 01 requirements.

B. The Work shall be in accordance with submittals that comply with the Contract Documents, except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Engineer’s review of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Engineer of such deviation at the time of submittal and (1) the Engineer has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation.

C. After approval of preliminary list of materials, the Contractor shall submit Shop Drawings and manufacturer's Certified Drawings to the Owner’s Representative for approval.

D. The Contractor shall submit Shop Drawings that comply with the Contract Documents and manufacturer's equipment cuts, of all equipment requiring connection by Division 26, to the Electrical Contractor for final coordination of electrical requirements. Contractor shall bear all additional costs for failure to coordinate with Division 26.

E. Delegated-Design Submittal: For structural pipe and equipment supports, vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic, and where required wind forces required to select vibration isolators, seismic and wind restraints, support framing members, and for designing vibration isolation bases.

F. Submittals and Shop Drawings:

1. Submit electronic copies of manufacturer's submittal sheets in one (1) coordinated package per specification section. Multiple submissions will not be accepted without prior approval of the Engineer or the Owner’s Representative. Organize submittal sheets in sequential order aligned with matching specification section numbers.
2. Provide electronic copies of shop drawings prepared to show details of the proposed installation. Copies of contract design drawings submitted to demonstrate shop drawing compliance will not be accepted.
3. Paper submittals will only be acceptable if specifically required by Division 01.
4. Submittals that comply with the Contract Documents shall be converted into Operations & Maintenance Manuals at the completion of the project. Refer to Division 01 for additional requirements.

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5. Mark each copy of each submittal to show which specific products, options, accessories, appurtenances, etc. are applicable to this specific project.
6. Include the following information, as applicable:
    a. Manufacturer's catalog cuts.
    b. Manufacturer's product specifications.
    c. Standard color charts.
    d. Statement of compliance with specified referenced standards.
    e. Testing by recognized testing agency.
    f. Application of testing agency labels and seals.
    g. Notation of coordination requirements.
    h. Availability and delivery time information.
    i. Environmental Product Declaration Submittal: For each product and piece of equipment, an acceptable Environmental Product Declaration Submittal shall be provided in accordance with MEP 2040. The submittal shall include the highest-preference option available, following the order of preference listed below, from highest to lowest:
        1) Product Specific, Facility Specific EPD
        2) Product Specific EPD
        3) Industry Average EPD
        4) TM65 Manufacturer Form with Mid-Level Calculation data
        5) TM65 Manufacturer Form with Basic Calculation data

        Requesting EPDs supports MEP 2040 participation and promotes the production of these documents by manufacturers while adding no cost to the project. If EPDs are not available for a particular product, the manufacturers shall provide a letter to be included in the submittal stating an EPD does not yet exist for their product on manufacturer letterhead.
7. For equipment, include the following in addition to the above, as applicable:
    a. Wiring diagrams that show factory-installed wiring.
    b. All required electrical operational and connection requirements.
    c. Connection requirements for all required systems, utilities and services to make equipment/product fully operational.
    d. Printed performance data and curves.
    e. Operational range diagrams.
    f. Equipment/product dimensions and weights, point loads, center-or-gravity, etc.
    g. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

1.16 COORDINATION DOCUMENTS/SHOP DRAWINGS

A. The Contractor shall prepare coordinated Shop Drawings using the same electronic format as the contract documents.

1. The shop drawings shall serve to record the coordination of the installation and location of all HVAC equipment, ductwork, grilles, diffusers, piping, fire sprinklers, lights, audio/video systems, electrical services and all system appurtenances.

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2. The Drawings shall include all mechanical rooms and floor plans.
3. The Drawings shall be keyed to the structural column identification system, and shall be progressively numbered. Prior to completion of the Drawings, the Contractor shall coordinate the proposed installation with the Owner's Representative and the structural requirements, and all other trades (including HVAC, Plumbing, Fire Protection, Electrical, Ceiling Suspension, and Tile Systems), and provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances. When conflicts are identified, modify system layout as necessary to resolve. Do not fabricate, order or install any equipment or materials until coordination documents are approved by the General Contractor and Owner's Representative.
4. Within thirty (30) days after award of Contract, submit proposed coordination document Shop Drawing schedule, allowing adequate time for review and approval by parties mentioned above. Drawings or electronic coordination should be prepared and submitted for approval on a floor-by-floor basis to phase with building construction.

B. The coordination work shall be prepared as follows:

1. Two dimensional AutoCAD / Revit based documents :

   a. Contractor shall prepare AutoCAD/Revit coordination drawings to an accurate scale of 1/4" = 1'-0" or larger. Drawings are to be same size as Contract Drawings and shall indicate locations, sizes and elevations above finished floor, of all systems. Lettering shall be minimum 1/8" high.
   b. Contractor shall obtain AutoCAD/Revit drawings from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the HVAC work.
   c. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
   d. Drawings shall incorporate all addenda items and change orders.
   e. Distribute drawings to all other trades and provide additional coordination as needed to assure adequate space for piping, equipment and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

2. Three dimensional Revit / BIM based documents :

   a. Provide three dimensional Revit model and BIM input information locating all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.
   b. Contractor shall obtain Revit model and BIM input from all other trades as required to fully coordinate the installation with architectural, structural, HVAC, plumbing, electrical, fire alarm devices, low voltage devices, and other systems that interface with and/or impact the fire protection work.
   c. Model shall indicate locations of all equipment and piping, including valves and fittings, dimensions from column lines, and bottom of pipe elevations above finished floor.

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d. Provide maintenance access clearance as required by manufacturer installation instructions and as required to meet minimum code clearances.
e. Model shall incorporate all addenda items and change orders.
f. Distribute Revit model and BIM input information to all other trades and provide additional coordination as needed to assure adequate space for equipment and piping and routing to avoid conflicts. When conflicts are identified, modify system layout as necessary to resolve.

C. Advise the Owner's Representative in the event a conflict occurs in the location or connection of equipment. Bear all costs for relocation of equipment, resulting from failure to properly coordinate the installation or failure to advise the Owner's Representative of conflict.

D. Verify in field exact size, location, invert, and clearances regarding all existing material, equipment and apparatus, and advise the Owner's Representative of any discrepancies between those indicated on the Drawings and those existing in the field prior to any installation related thereto.

E. Final Coordination Drawings with all appropriate information added are to be submitted as Record Drawings at completion of project.

F. Provide copy of Record Drawings to Testing and Balancing Contractor for their use when doing their work.

1.17 SUBSTITUTIONS

A. General: In addition to all other requirements included in Division 01, by submitting a bid, the Contractor represents that its bid is based on materials, equipment and performance described in the Contract Documents, including Addenda. Contractors shall request approval for use of proposed substitute materials and equipment when the Contract Documents list materials and equipment by product or manufacturer name and/or model number.

B. Definitions

1. Substitutions: Changes in products, materials, equipment, and methods of construction from those specified in the Contract Documents.

C. Substitution Requests will be received and considered by Owner when the following conditions are satisfied, as determined by the Engineer; otherwise, requests will be returned without action:

1. Revisions to the Contract Documents are not required.
2. Revisions to the Contract Documents are required and Contractor's substitution request includes provisions for both schedule affects, and all costs associated with required additional Design and Engineering fees to incorporate Contractor's proposed substitution.
3. Proposed substitution is in keeping with the general intent and performance requirements of the Contract Documents, including the level of quality of the Work represented by the requirements therein.
4. The substitution request is fully documented and properly submitted in a timely fashion.

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5. Substitution requests submitted for retroactive approval of already installed products and materials will be rejected.

D. Substitution Requests shall be made in writing by Contractor in accordance with the following requirements:

1. While requests for Substitution shall be submitted no later than 30 days after contract award, Contractor is encouraged to submit such requests for Substitution during the bid period. All bids that are based on unapproved Substitutions shall be at the Contractor's sole risk.
2. Substitution Format: Unless otherwise specified in Division 01 requirements, submit written Substitution requests using CSI Substitution Request Form 1.5C.
    a. Identify the proposed Substitution product, fabrication or installation to be replaced in each Substitution request. Include within each request the related contract document reference to include specification Section(s) and/or drawing sheet number(s).
    b. Provide complete documentation on both the specified product and the proposed Substitution, including the following information as may be appropriate:
        1) Statement indicating why specified product or fabrication or installation method cannot be provided or why substitution is being proposed.
        2) Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution. Coordination information shall identify cost savings or increases associated with the proposed Substitution and shall include all additional design and engineering fees as well as additional construction costs necessary to incorporate.
        3) Point-by-point comparison of specified and proposed substitute product data, fabrication drawings, and installation procedures. This shall include detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, utility consumption, energy efficiency, weight, size, durability, visual effect, sustainable design characteristics, maintenance and maintainability, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
        4) Samples, where applicable or when requested by Owner or Engineer.
        5) Certificates and qualification data, where applicable or requested.
        6) List of similar installations for completed projects, with project names and addresses as well as names and addresses of architects and owners.

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7) Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
8) Research reports evidencing compliance with building code in effect for Project as may be required.
9) Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.
10) Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
11) Cost information, including a proposal of change, if any, in the Contract Sum.
12) Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
13) Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

E. Contractor’s proposed Substitutions shall fully include the costs of the design team to review and to incorporate the proposed substitution into the Contract Documents including all redesign and re-engineering fees. Contractor shall also, as a part of the substitution request, identify the funding mechanism to compensate the design and engineering team for approved Substitutions that require additional design and engineering to successfully incorporate into the project. Substitutions that do not account for redesign and re-engineering costs will not be reviewed.

F. Engineer's approval of a substitute does not relieve Contractor of the responsibility to submit required shop drawings and coordination drawings and to comply with all other requirements of the Contract Documents.

1.18 REQUESTS FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified (refer to Division 01).

1. Coordinate and submit each RFI in a prompt manner to avoid delays in Contractor's work or work of subcontractors.
2. Each RFI shall address single questions and related issues only.
3. Each RFI shall be thoroughly reviewed and approved by the General Contractor and/or Construction Manager for accuracy and need for information required before submittal to the Owner’s Design Representative.

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B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. Project number.
3. Date.
4. Name of Contractor.
5. Name of Architect and/or Construction Manager.
6. RFI number, numbered sequentially and unique.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. Engineer’s Action: Engineer will review each RFI, determine action required, and respond. Allow a minimum three business days for Engineer's response to each RFI, plus additional time for Architect and General Contractor to review and forward. Each RFI received by Engineer after 1:00 p.m. will be considered as received the following business day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Incomplete RFIs or inaccurately prepared RFIs.
    b. RFIs submitted without indication of review and approval for submission by General Contractor or Construction Manager.
    c. RFIs addressing multiple unrelated issues.
    d. Requests for approval of submittals.
    e. Requests for approval of substitutions.
    f. Requests for approval of Contractor's means and methods.
    g. Requests for information already indicated in the Contract Documents.
    h. Requests for adjustments in the Contract Time or the Contract Sum.
    i. Requests for interpretation of Engineer's actions on submittals.

2. Engineer's action may include a request for additional information, in which case Engineer's time for response will date from time of receipt of additional information.

1.19 RECORD DOCUMENTS

A. Maintain set of Coordination Documents (drawings and specifications) marked “Record Set” at the job site at all times and use it for no other purpose but to record on it all the changes and revisions during construction.

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B. Record Drawings shall indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned to column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e. – valves, traps, strainers, expansion compensators, tanks, etc.).

C. Record Specifications shall indicate approved substitutions; Change Orders; and actual equipment and materials provided.

D. Provide copy of Record Documents to Testing and Balancing Contractor and Commissioning Agent for use when performing their work.

E. At the completion of the construction transfer all “Record Set” notations to a clean set of drawings and specifications in a neat and orderly fashion that incorporates all site markups to clearly show all changes and revisions to the Contract Documents. Submit copies of Record Documents and CD/DVD disks labeled with all drawings and specifications and other supporting documentation.

F. Refer also to Division 01 for full scope of requirements.

1.20 START-UP SERVICE AND BUILDING COMMISSIONING

A. Prior to start-up, be assured that systems are ready, including checking the following: Proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting, controls, and installed and properly set relief and safety valves.

B. Provide services of factory-trained technicians for start-up of air conditioning units, temperature controls, chillers, boilers, pumps, and other major pieces of equipment. Certify in writing compliance with this Paragraph, stating names of personnel involved and the date work was performed.

C. Provide certificates of calibration for all sensors required for control and monitoring including temperature and pressure.

D. A commissioning plan and report must be submitted.

E. Contractor shall submit one electronic and five (5) hard copies of commissioning documents to Project Manager.

F. Commissioning agent needs to review submittals and O&M’s.

G. Commissioning agent shall coordinate training of PSU personnel.

H. There must be a mandatory review of system/equipment within one year of building turn over.

I. Commissioning agent shall maintain an activity/action log throughout entire commissioning process.

J. Refer to other Division 23 Sections for additional requirements.

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1.21 INSTALLATION, OPERATION, AND MAINTENANCE (IOM) MANUALS

A. Installation, Operation, and Maintenance (IOM) Manuals: Upon completion of the work, and prior to training of Owner's personnel, the Contractor shall submit to the Owner's Representative a complete set of operating instructions, maintenance instructions, part lists, and all other bulletins and brochures pertinent to the operation and maintenance for equipment furnished and installed as specified in this section, in electronic format within a single folder structure with one folder per specification section. Refer to Division 01.

B. Contractor shall be responsible for providing proper instruction of the of Owner's personnel for operation and maintenance of equipment, and apparatus installed as specified in Division 23. Training is to be appropriate to the complexity of the equipment. The Contractor shall develop and submit training materials prior to this training. These materials shall include qualifications of the trainer, training agenda, learning objectives, and a written test to be administered at the end of the training session. Operation and Maintenance manuals must present, incorporated and referenced in the training sessions.

1.22 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage. Piping and equipment showing signs of rust shall be removed from site and replaced with new.

1.23 POSTED OPERATING INSTRUCTIONS

A. Furnish approved operating instructions for systems and equipment indicated in the technical sections for use by operation personnel. The operating instructions shall include wiring diagrams, control diagrams, and control sequence for each principal system and equipment. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. Attach or post operating instructions adjacent to each principal system and equipment including start-up, operating, shutdown, safety precautions and procedure in the event of equipment failure. Provide weather-resistant materials or weatherproof enclosures for operating instructions exposed to the weather. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal.

1.24 SAFETY AND INDEMNITY

A. The Contractor shall be solely and completely responsible for conditions of the job site including safety of all persons and property during performance of the work. This requirement will apply continuously and not be limited to normal hours of work.

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B. No act, service, Drawing, review, or Construction Review by the Owner's Representative, Architect, the Engineers or their consultants, is intended to include the review of the adequacy of the Contractor's safety measures, in, on, or near the construction site.

C. The Contractor performing work under this Division of the Specifications shall hold harmless, indemnify and defend the Owner, the Architect, the Engineers and their consultants, and each of their officers, employees and agents from any and all liability claim, losses or damage arising, or alleged to arise from bodily injury, sickness, or death of a person or persons, and for all damages arising out of injury to or destruction of property arising directly or indirectly out of, or in connection with, the performance of the work under the Division of the Specifications, and from the Contractor's negligence in the performance of the work described in the Construction Contract Documents; but not including the sole negligence of the Owner's Representative, the Architect, the Engineers, and their consultants or their officers, employees and agents.

1.25 CLEANING AND CLOSING

A. All work shall be inspected, tested, and approved before being concealed or placed in operation.

B. Upon completion of the work, all equipment installed as specified in this section, and all areas where work was performed, shall be cleaned to provide operating conditions satisfactory to the Owner's Representative.

1.26 WARRANTIES

A. Refer to general terms and conditions, as well as warranties and obligations defined in Division 1 of the specifications that provide basic warranty requirements for the entire project.

B. The warranties and corrective obligations provided under this section (i) are in addition to, and not in lieu of, any other warranty, representation, covenant, duty or other obligation (including any corrective obligation) of the Contractor or Manufacturer, (ii) have no relationship to the time when any warranty, representation, duty, covenant or other obligation of Contractor or Manufacturer may be enforced or any dispute resolution proceeding commenced and (iii) are made by the Manufacturer to both the Contractor and the Owner and by the Contractor to Owner.

C. All equipment and systems shall be provided with a minimum one-year warranty, or longer, as defined in each subsequent specification section. Warranty shall include all parts, material, labor and travel.

D. Warranty Start Date: The start date for all warranty periods shall be defined as starting from the date of Substantial Completion which shall include the Certificate of Occupancy from the Authority Having Jurisdiction.

E. Refer to individual Specification sections for additional extended warranty requirements.

F. Provide complete warranty information for each item, to include product or equipment, date of beginning of warranty or bond; duration of warranty or bond; and names,

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addresses, telephone numbers and procedures for filing a claim and obtaining warranty services.

G. Nothing in any separate warranty or other document provided by Contractor or Manufacturer, or both, will apply to limit their liability or responsibility for damages arising out of or related to a breach of any warranty or corrective obligation.

H. Service during warranty period: Contractor shall provide maintenance as specified elsewhere during the 12-month warranty period.

I. Close-out submittals: Upon completion of the work, Contractor shall submit all warranty information for all equipment within this division in electronic format within a single folder structure per specification section.

1.27 GUARANTEE

A. The Contractor shall guarantee and service all workmanship and materials to be as represented by him and shall repair or replace, at no additional cost to the Owner, any part thereof which may become defective within the period of one (1) year, minimum, after Substantial Completion, ordinary wear and tear excepted

B. Contractor shall be responsible for and pay for any damages caused by or resulting from defects in this work.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer's name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to product materials and installation of supports and anchors, including, but not limited to, the following:

1. UL and FM Compliance: Provide products, which are UL listed and FM approved.
2. ASCE 7 (Latest Edition): American Society of Civil Engineers-Minimum Design Loads for Buildings and Other Structures.
3. MSS Standard Compliance: Manufacturer's Standardization Society (MSS).
4. SMACNA: Seismic Restraint Manual: Guidelines for Mechanical Systems.
5. NFPA: Pamphlet number 13 and 14 for fire protection systems.
6. Provide copper plated or plastic coated supports and attachment for copper piping systems. Field applied coatings or tape is unacceptable.

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7. Manufacturer: Mason Industries, Hilti Inc., B-Line/Tolco (Eaton), Anvil, Erico, Kin-Line, Simpson Strong-Tie Co. Inc., Superstrut, Empire, PHD Manufacturing, Carpenter & Paterson, Powers Fasteners or equal.

B. Horizontal Piping Hangers and Supports: Except as otherwise indicated, provide factory-fabricated hangers and supports of one of the following MSS SP-58 types listed.

1. Adjustable Steel Clevis Hangers: MSS Type 1.
2. Adjustable Steel Swivel Band Hangers: MSS Type 10.
3. U-Bolts: MSS Type 24.
4. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
    a. Plate: Unguided type.
    b. Plate: Guided type.
    c. Plate: Hold-down clamp type.
5. Pipe Saddle Supports: MSS Type 36, including steel pipe base support and cast iron floor flange.
6. Pipe Saddle Supports with U-Bolt: MSS Type 37, including steel pipe base support and cast iron floor flange.
7. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast iron floor flange.
8. Upper Attachment Side Beam Bracket: MSS Type 34
9. Upper Attachment Side Beam Angle Bracket: MSS Type 34, UL listed and FM Approved.
10. Single Pipe Roller with Malleable Sockets: MSS Type 41. Rollers are not required for hydronic piping where spring hangers are utilized.
11. Adjustable Roller Hangers: MSS Type 43. Rollers are not required for hydronic piping where spring hangers are utilized.
12. Pipe Roll Stands: MSS Type 44.
13. Pipe Guides: Provide factory-fabricated guides of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base with a two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

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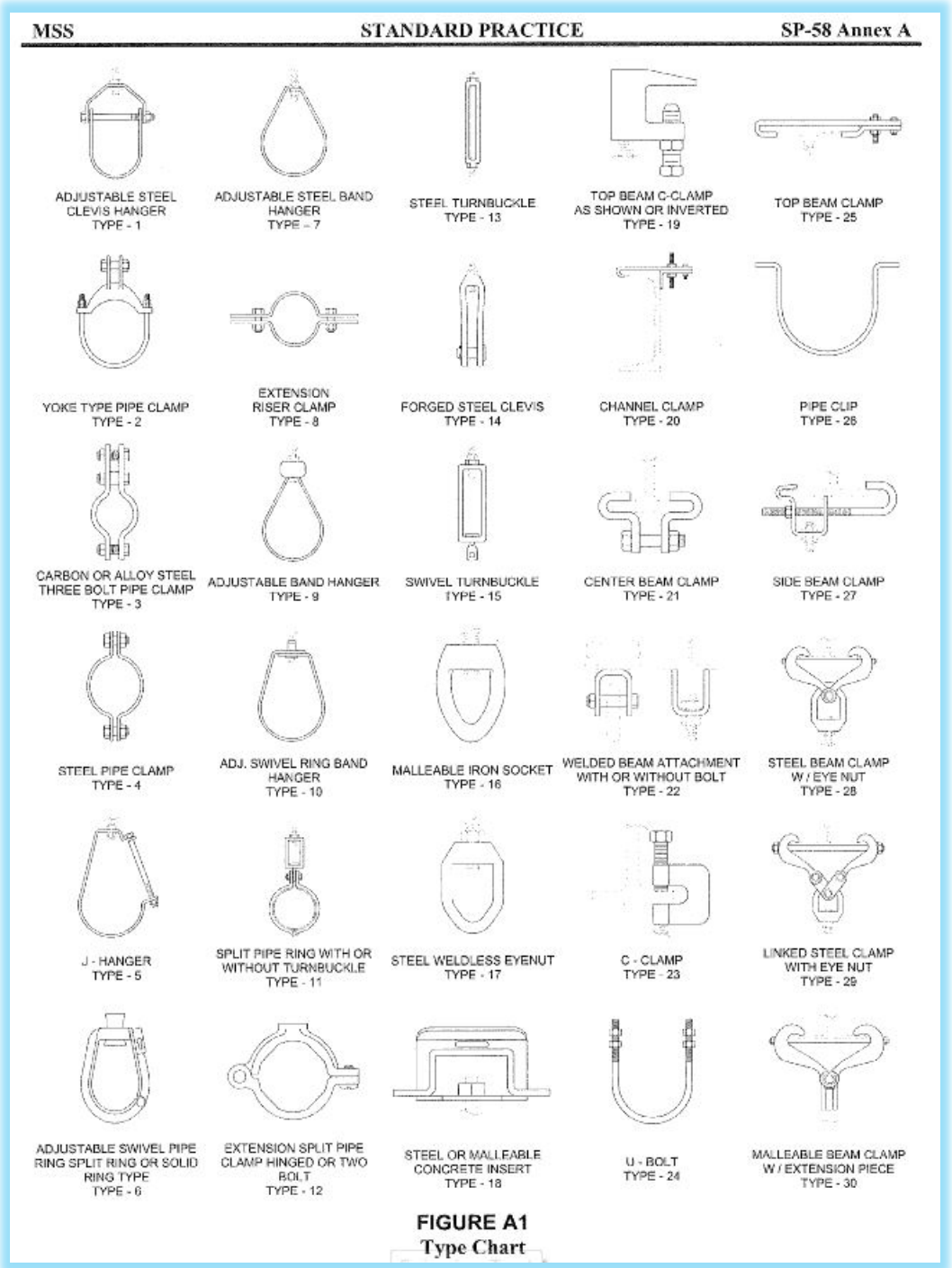


FIGURE A1
Type Chart

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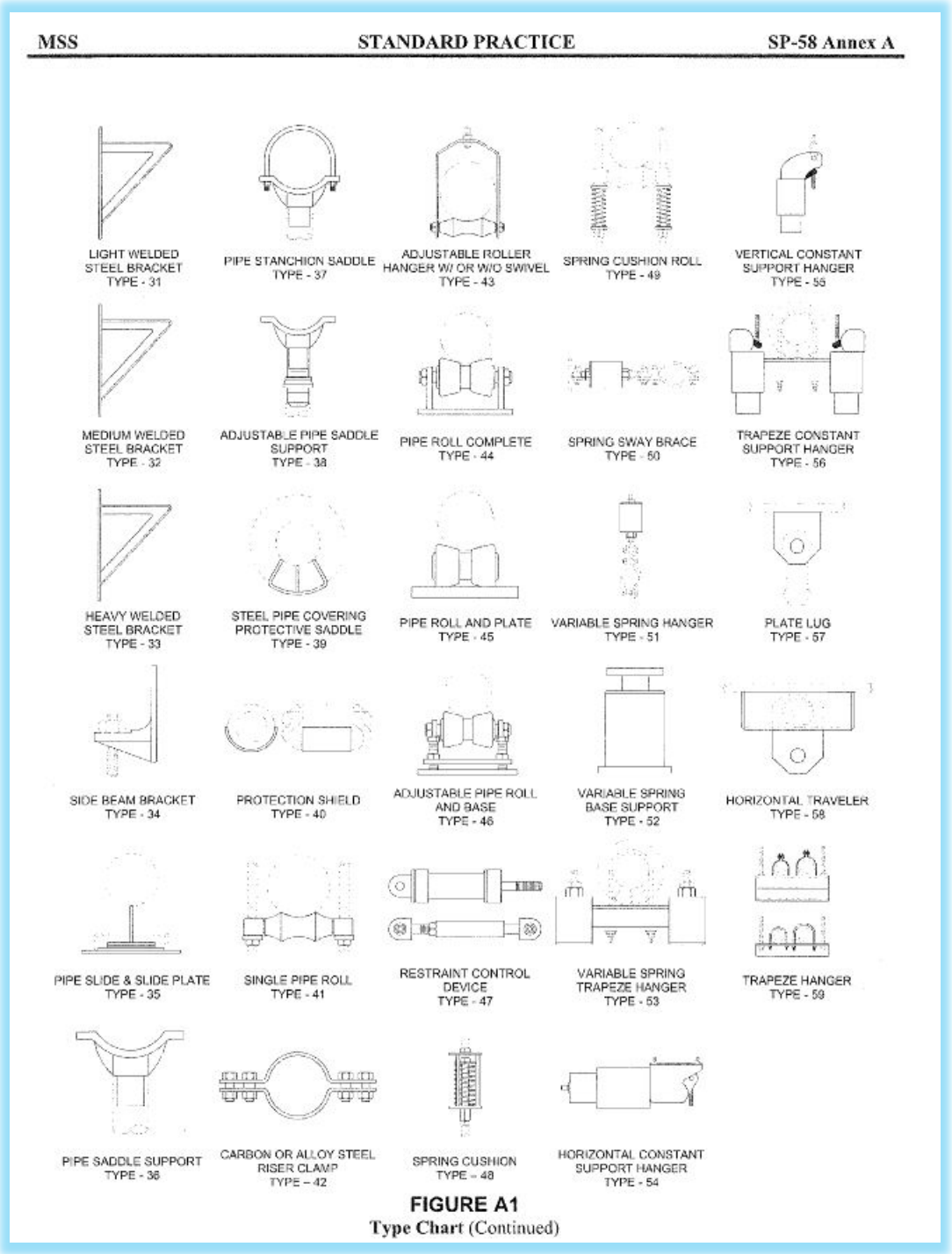


FIGURE A1
Type Chart (Continued)

C. Horizontal Cushioned Pipe Clamp: Where pipe hangers are called out to absorb vibration or shock install a piping clamp with thermoplastic elastomer insert. Cush-A-Clamp type by many manufacturers.

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D. Vertical Piping Clamps: Provide factory-fabricated two-bolt vertical piping riser clamps, MSS Type 8 and or four-bolt riser clamps for heavy loads, MSS Type 42. Provide with 1” thick (minimum) neoprene pad on floor with 1/4" thick steel plate to distribute riser clamp weight to pad.

E. Hanger-Rod Attachments: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments of one of the following MSS types listed. Hanger rods shall be steel, galvanized steel, threaded on both ends, or continuously threaded.

1. Steel Turnbuckles: MSS Type 13.
2. Steel Clevises: MSS Type 14.
3. Swivel Turnbuckles: MSS Type 15.
4. Malleable Iron Eye Sockets: MSS Type 16.
5. Steel Weldless Eye Nuts: MSS Type 17.

F. Building Attachments: Except as otherwise indicated by the Structural Engineering design, provide factory-fabricated building attachments of one of the following types listed.

1. Concrete Inserts:
    a. MSS Type 18.
    b. Manufacturers: Hilti #KCS-MD (for metal deck) or HCI-WF (for wood forms), Simpson Strong Tie #Blue Banger Hanger, Powers Fasteners #Bang-It (for metal deck) or #Wood-Knocker (for wood forms), or equal.
2. Steel Brackets: One of the following for indicated loading:
    a. Light Duty: MSS Type 31.
    b. Medium Duty: MSS Type 32.
    c. Heavy Duty: MSS Type 33.
3. Horizontal Travelers: MSS Type 58.
4. Concrete Screw Anchors: For floor mounted attachments with maximum allowable pullout and shear force of 250 lbs. (1.1 kN) per anchor regardless of size.
    a. Manufacturers: Hilti #Kwik Hus EZ-I, Simpson Strong-Tie #Titen HD (or Rod Hanger version), Powers Fasteners #Wedge-Bolt+ (Screw Anchor), Powers Fasteners #Vertigo+ (Rod Hanger), Powers Fasteners #Snake+ (Internally Threaded Screw Anchor), or equal.
5. Torque-Controlled Expansion Anchor:
    a. Manufacturers: Hilti #Kwik Bolt TZ2, Simpson Strong Tie #Strong-Bolt 2, Powers Fasteners #Power-Stud+ SD1 or Power-Stud+ SD2, or equal.
6. Screws and Bolts:
    a. Manufacturers: Bolt Depot, Fastenal, National Bolt & Nut, or equal.
7. Eye Bolts:
    a. Manufacturers: Lawson Products, Sierra Pacific, US Cargo Control, or equal.

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8. Powder-Driven Concrete Anchors:
    a. Only for existing concrete structures with minimum 4000 psi concrete compressive strength.
    b. Minimum embedment of 1” (25 mm).
    c. Maximum allowable load of 50 lbs. (0.2 kN) per anchor.
    d. Manufacturer: Hilti #X or D Series, Powers Fasteners #CSI Series, or equal.

G. Saddles and Shields: Except as otherwise indicated, provide saddles or shields under piping at hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with adjacent pipe insulation. Insulation shall be continuous through each support with no direct contact between pipes and support elements wherever pipes are required to be insulated.
1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
2. Insulation Protection Shields: MSS Type 40, 18" minimum, or of the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall match or exceed shield length.
3. Thermal Hanger Shields: Constructed of 360° insert of waterproofed calcium silicate (60 psi flexural strength minimum) encased in 360° sheet metal shield. Provide assembly of same thickness as adjoining insulation. Shield length shall match or exceed length of calcium silicate insert.
    a. Pre-manufactured insulated pipe shields are an acceptable alternate when installed per manufacturer’s instructions for pipe sizes to 6” diameter. Manufacturers: SnappItz, Armacell #ArmaFix Ecolight or equal.
4. Thermal Hanger Couplings: Constructed of high strength plastic coupling to retain un-insulated tubing at clevis hangers and strut-mounted clamps. Allowed for pipe diameter up to 4”.
    a. Manufacturers: Hydra-Zorb #Klo-Shure Insulation Couplings, Mason Industries #MW-SCCI or equal.
5. Welded Pipe Hanger Lug: For use on each insulated chilled and heating water pipe at lateral and longitudinal seismic restraint locations to allow for support attachment outside of the insulation jacket. Heavy gauge steel U shaped lug with support hole. Gauge and dimensions as required for supported system and insulation thickness. Lug shall be welded to pipe at required seismic restraint locations for lateral and/or longitudinal control.
    a. Manufacturers: Mason Industries #MW-WPL or equal. Where welding is explicitly not allowed, based on project criteria, the use of pipe clamps with pre-welded lugs may be allowed through the submittal process using Mason Industries #MW-SPC or equal.

H. Miscellaneous Materials:
1. Metal Framing: Provide products complying with NEMA STD ML1.
2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A36.

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3. Cement Grout: Portland Cement (ASTM C150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C404, Size No. 2). Mix at a ratio of one-part cement to three-parts sand by volume, with minimum amount of water required for placement and hydration.
4. Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required. Weld steel in accordance with AWS standards.
5. Pipe Brackets: Copper plated brackets and supports for various mounting options. Insulate brackets attached to metal studs with felt.
    a. Manufacturers: Holdrite or equal.

2.3 ACCESS DOORS FOR WALL AND CEILING APPLICATIONS

A. Provide all access doors and panels to service equipment under this work, including those which must be installed, in finished architectural surfaces. Refer to other specification sections for specific access doors associated with ductwork and equipment.

B. Construction:

1. Frame: 16-gauge steel (minimum).
2. Door: 16-gauge steel (minimum) or two layers of 20-gauge steel (minimum) for double wall door construction.
3. Hinge: 1" flange width, continuous piano hinge.
4. Latching System: screwdriver latch, allen key latch or T-handle latch for non-public access areas. Cylinder key lock for public access areas. Cam latch for access to fire/life safety systems.
5. Paint: white prime coated.

C. Size:

1. Access doors shall be of a size to permit access and removal of equipment for servicing. Access door shall have same rating as the wall or ceiling in which it is mounted. Provide access panel for each trap primer, concealed valve, fire and combination fire/smoke dampers, volume dampers, and other equipment requiring access. Use no panel smaller than 12" x 12" for simple manual access, or smaller than 24" x 24" where personnel must pass through.

D. Architectural Coordination:

1. Refer to Division 01 Architectural specifications and drawings for additional requirements for each surface. Contractor is to submit schedule of access panels for approval. Exact size, number and location of access panels are not shown on Plans.
2. Included under this work is the responsibility for verifying the exact location and type of each access panel or door required to service equipment under this work and in the proper sequence to coordinate with construction schedule and with prior approval of the Owner’s Representative.
3. Access doors in fire rated partitions and ceilings shall carry all label ratings as required to maintain the rating of the rated assembly.
4. Submit markup of architectural plans showing size and location of access panels required for equipment access for approval by Owner’s Representative.

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E. Manufacturers: Milcor, Karp, Nystrom, Elmdor/Stoneman, Durodyne, Austin Hardware, or equal.

2.4 IDENTIFICATION MARKERS

A. Mechanical Identification Materials: Provide products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for application, selection is installer's option, but provide single selection for each product category. Stencils, hand printed, painted, and felt pen markers are not acceptable.

1. Labels shall be printed to match the abbreviations or spelled out names used in the construction drawings. Custom printed labels are acceptable for specialty services and equipment.

B. Plastic Pipe Markers:

1. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially or fully cover the circumference of pipe, or insulated pipe, and to attach to pipe without fasteners or adhesive complying with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles. Minimum letter size shall be 1/2” high.
2. Pressure Sensitive Type: Provide pre-printed, permanent adhesive, color coded, pressure sensitive vinyl pipe markers, complying with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles. Secure both ends of markers with color coded adhesive vinyl tape.
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker. Note if polypipe or plastic pipe is being used on insulation jacket per PSU Technical Design Standards.
4. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
5. Nomenclature shall include service type and directional arrow as follows:

a. Refrigerant: yellow background with black lettering.
b. Exhaust air: blue background with white lettering.
c. Other piping services: Comply with ANSI and ASME A13.1standards.
d. Direction of water flow.

C. Plastic Duct Markers:

1. Provide duct labels to indicate the system and direction of flow. Submit a labeling product that is suitable for the surface to be labeled. Duct labels to comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles

a. Pressure sensitive, 16” long by 2-1/4” high (minimum), 3 mil thick high gloss adhesive backed vinyl, 1-1/2” high letters, and color coded per ducted service.

2. Nomenclature shall include service type and directional arrow as follows:

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a. Supply air (cold service): green background with white lettering.
b. Supply air (hot service): yellow background with black lettering.
c. Return air: blue background with white lettering.
d. Relief air: blue background with white lettering.
e. Exhaust air: blue background with white lettering.
f. Other air services: Comply with ANSI and ASME A13.1standards.
g. Direction of air flow.

D. Access Panel Markers: Provide 1/16" thick (minimum) engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve or device to indicate purpose of access.

E. Plastic Equipment Signs:

1. Provide 4-1/2” x 6” (minimum) plastic laminate sign, ANSI A13.1 color coded with engraved white core lettering. Minimum letter size shall be 1/2” high.
2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.
3. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

a. Tag number
b. Equipment service.
c. Design capacity.
d. Other design parameters, such as pressure drop, entering and leaving conditions, rpm, etc.

4. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2”x11” bond paper, tabulate each equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

F. Ceiling Tile Labels for Equipment

1. Provide machine generated, adhesive backed, ANSI A13.1 color coded with engraved black core lettering, labeled orange labels for equipment on ceiling tiles per PSU Technical Design Standards.

G. Ceiling Tile Labels for Dampers

1. Access points for dampers and their accessories shall be visibly labeled from occupied space.

H. Acceptable Manufacturers: Craftmark, Seton, Brady, Marking Services, Kolbi, or Brimar.

2.5 ACOUSTICAL BLANKET INSULATION

A. Application:

1. Wrap high noise producing equipment and ductwork where occupied room noise levels cannot be obtained by architectural room barrier construction alone.

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a. Wrap each variable air volume terminal where located above noise sensitive rooms such as conference rooms, lobbies and offices.
b. Wrap ductwork where located above noise sensitive rooms such as conference rooms, lobbies and offices.
c. Wrap fans where located above noise sensitive rooms such as conference rooms, lobbies and offices.
d. Wrap chillers and pumps where located adjacent to noise sensitive rooms.

B. Manufacturers: Kinetics Noise Control #KNM-100ALQ, or equal by BRD Noise and Vibration Control, GLT Products #Vinaflex with Absorber/Decoupler, or Singer Safety Company, Quilted Fiberglass Panels.

C. Composite material, quilted, with reinforced aluminized-face, mass loaded limp vinyl bonded to scrim-face, quilted fiberglass absorber/decoupler.

D. The barrier shall be constructed of a 0.12” (3 mm) minimum, thick mass loaded, limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side. The barrier shall have a minimum weight of 1.0 lbs./ft^2 (4.9 kg/m^2) and shall have a minimum STC rating of 28 as measured in an independent accredited acoustical laboratory in accordance with ASTM E90 and/or E413.

E. The decoupling layer shall be a combination of 1.0” (25 mm), minimum, fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4” (100 mm) diamond stitch pattern which encapsulates the glass fibers.

F. The composite material shall be fabricated to include a minimum 2” (50 mm) wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints.

G. The barrier shall have a Flame Spread Index of no more than 10 and a Smoke Development Index of no more than 40 when tested for Surface Burning Characteristic per ASTM E84.

2.6 ELECTRICAL

A. General:

1. Mechanical Contractor shall be responsible for coordinating all electrical requirements of mechanical equipment with Electrical Contractor prior to procurement or installation.
2. All electrical material, equipment, and apparatus specified herein shall conform to the requirements of Division 26.
3. Provide all motors for equipment specified herein. Provide motor starters, controllers, and other electrical apparatus and wiring which are required for the operation of the equipment specified herein.
4. Set and align all motors and drives in equipment specified herein.
5. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

B. Quality Assurance:

1. Electrical components and materials shall be UL or ETL listed/labeled as suitable for location and use - no exceptions.

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C. Low Voltage Control Wiring:

1. General: 14-gauge, Type THHN, color coded, installed in conduit.
2. Manufacturer: General Cable Corp., Alcan Cable, American Insulated Wire Corp., Senator Wire and Cable Co., or Southwire Co.

D. Disconnect Switches:

1. Fusible Switches: For equipment 1/2 HP or larger, provide fused, each phase; heavy duty; horsepower rated; spring loaded quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the “OPEN” position; arc quenchers; capacity and characteristics as indicated.
2. Non-Fusible Switches: For equipment less than 1/2 horsepower, switch shall be horsepower rated; toggle switch type with thermal overload quantity of poles and voltage rating as required.

2.7 REFRIGERANT-CONTAINING SYSTEMS

A. Where equipment containing refrigerant is specified to be provided within the scope of the project, the Contractor shall coordinate with the manufacturer to furnish and install hardware and accessories as necessary to comply with current applicable codes.

PART 3 - EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or as approved by Owner’s Representative.

3.2 MANUFACTURER'S DIRECTIONS

A. Follow manufacturers' directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

1. If the contractor must deviate from the manufacturer’s recommendations provide a letter from the manufacturer indicating the clearance to be provided is acceptable for scheduled performance and maintenance.

3.3 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions. If any cooperative work must be altered due to lack of proper supervision or failure to make proper and timely provisions, the alternations shall be made to the satisfaction of the Engineer and at the Contractor’s cost.

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Coordinate wall and ceiling work with the General Contractor, and other trades in locating ceiling air outlets, wall registers, etc.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any damaged or defected materials.

C. Coordinate all condensate piping from cooling coils with Division 22 work. Water trap depth shall not be less than 3” and increased where system static pressure exceeds 2” external static plus 1” additional safety factor.

1. Install manufacturer provided condensate “air-traps” where provided with cooling equipment and condensing boilers. Install traps per manufacturer’s instructions and install condensate piping as required by local code.

3.4 SUPPORTS AND HANGERS

A. Prior to installation of hangers, supports, anchors, and associated work, installer shall meet at project site with the General Contractor, installer of each component of associated work, inspection and testing agency representatives, (if any), installers of other work with requirements specified.

B. Installation of Building Attachments: Install building attachments at required locations within concrete or on structural steel for proper piping support. Install additional building attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed. Fasten insert securely to forms. Where Gypcrete is indicated, install reinforcing bars through opening at top of inserts. Inserts and anchors shall be located no closer than 6” to any edge and no closer than 1” from any pre-tension cables or embedded steel and as required per manufacturer’s instructions and Structural Engineer.

C. Proceed with installation of hangers, supports, and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including, but not limited to, proper placement of inserts, anchors, and other building structural attachments.

D. Install hangers, supports, rails, clamps, and attachments to support piping properly from building structure. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers and rails where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

E. Install pipe supports (hangers, rails, etc.) within 12 inches of every change in piping direction (only one support required at each change in direction), end of pipe run or concentrated load, and within 36 inches of every major piece of equipment. Supports (hangers, rails, etc.) shall be installed on both sides of flexible connections. Where flexible connection connects directly to a piece of equipment only one support is required.

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F. Install hangers, rails, and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

G. Provide pipe supports for insulated piping using pipe shields, saddles, or other approved means to prevent damage to insulation, pipe, and supports while maintaining insulation integrity.

1. Select type and configuration of supports based on Contractor's means and methods, pipe size, insulation thickness and type, insert materials, provision for thermal expansion, and anticipated loads including seismic, thermal, and concentrated loads at supports.
2. Supports shall:

a. Prevent compression and/or deformation of insulation, of inserts, of the pipe and of the supports themselves.
b. Distribute loads adequately to maintain continuous insulation performance.
c. Be compatible with insulation system and vapor barrier requirements.
d. Be suitable for the operating temperature and service of the piping system.
e. Provide for smooth, non-binding axial movement as may be required.

3. Install supports in accordance with manufacturer recommendations for insulation system and support components, in accordance with the delegated seismic anchorage and restraint requirements, as well as in accordance with thermal expansion requirements.

H. Support sprinkler piping and gas independently of other piping.

I. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

J. Hanger Spacing in accordance with following minimum spans for support of individual pipes. Hanger spacing shall follow guidelines per OMSC and SMACNA standards. Install a minimum of one hanger within 12" of each change of direction (only one required on either side of elbow), at the end of deadend pipe runs and within 36" of every piece of equipment. For straight runs of horizontal piping with no concentrated loads such as valves, flanges, expansion joints, or other components. Sections of piping with concentrated loads will have to be considered carefully and a determination made as to appropriate spacing and rod size for the given situation. Other spacing and rod sizes may be considered in compliance with Table 121.5 of ASME B31.1, ANSI/MSS SP-58 Table 4, and local mechanical code, but shall not exceed 12 feet for any pipe size. Comply with more restrictive requirements of local codes where those exceed the following minimum criteria.

1. Steel Pipe:

Steel Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2" to 1"	7 feet	3/8"
1-1/4" to 2-1/2"	10 feet	3/8"
3" to 4"	12 feet	3/8"

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5” to 8”	12 feet	1/2"
10” to 12”	12 feet	5/8”
14” to 16”	12 feet	3/4"

2. Copper Pipe:

Copper Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
1/2"	4 feet	3/8”
3/4” to 2”	6 feet	3/8”
2-1/2” to 4”	8 feet	3/8”
5” to 8”	8 feet	1/2"

3. Plastic/Fiberglass Pipe:

Plastic/Fiberglass Pipe Size	Hanger/Support Spacing (Maximum)	Rod Size (Minimum)
Up to 1”	3 feet	3/8”
1-1/4” to 2-1/2”	4 feet	3/8”
3” to 8”	4 feet	1/2"

4. Trapeze support: Provide details stamped by a Registered Structural Engineer for the project state indicating trapeze channels, support rod sizes, and spacing.
5. Maximum threaded rod loading: Below are maximum loads for hanger rods based on ASHRAE Fundamentals Handbook (Pipe Design Chapter) and ASTM A36, with a safety factor.

Maximum Allowable Loading Capacity for Hanger Rod in Tension	
Nominal Rod Diameter	Load (Maximum Weight)
3/8”	610 pounds
1/2"	1,130 pounds
5/8”	1,810 pounds
3/4"	2,710 pounds
7/8”	3,770 pounds
1”	4,960 pounds

K. Provisions for Movement:

1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
2. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connecting equipment.
3. Insulated Piping: Comply with the following installation requirements:
   a. Clamps: Attach clamps, including spacers, (if any), to piping with clamps projecting through insulation.
   b. Shields: Where low compressive strength insulation or vapor barriers are indicated on cold or chilled water piping, install shields or inserts.

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c. Saddles: Where insulation without vapor barrier is indicated install protection saddles.

L. Installation of Anchors:

1. Install anchors at proper locations to prevent excessive stresses and to prevent transfer of loading and stresses to connected equipment.
2. Fabricate and install anchor by welding steel shapes, plates and bars to piping and to structure.
3. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
4. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends.

M. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

N. Equipment Supports:

1. Provide all concrete bases, unless otherwise furnished as work of Division 03. Furnish to Division 03 Contractor scaled layouts of all required bases, with dimensions of bases, and location to column centerlines. Furnish templates, anchor bolts, and accessories necessary for base construction. Coordinate size of concrete pads and placement of anchors bolts with structural design. Anchor bolts shall be placed to maintain 6”, minimum, or greater distance from concrete pad edges.
2. Provide structural steel stands to support equipment above floor mounted or suspended from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks.

O. Adjusting:

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1. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments.
2. Support Adjustment: Provide grout under supports to align piping and equipment to proper level and elevations.
3. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

P. Upper Building Attachments: Powder-actuated fasteners may be used where appropriate for construction materials to which hangers are being attached per the following:

1. Maximum allowable tension load shall not exceed 50 lbs. (0.2 kN) per attachment.
2. May only by used to supporting for ductwork up to two (2) square feet (0.2 m^2) in cross sectional area and for control conduit clips.
3. May not be used for support of any ductwork greater than two (2) square feet (0.2 m^2) in cross sectional area.
4. Use concrete inserts before placing concrete in new construction.
5. Install powder-actuated concrete fasteners after concrete is placed and completely cured to concrete compressive strength of 4000 psi or greater.
6. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
7. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
8. Do not use powder-actuated concrete fasteners for seismic restraints.

3.5 WALL, FLOOR, AND ROOF PENETRATIONS

A. All pipe and duct penetrations through rated and non-rated assemblies shall be sized to allow for compliance with structural integrity and fire ratings, as applicable. Penetrations of fire-resistance-rated assemblies shall be protected by an approved firestop system installed and tested in accordance with ASTM E814 or UL 1479. The system shall have an F rating/T rating of not less than the required rating of the floor or wall penetrated. Where sleeves are required, the sleeve size shall be installed with the inside clear diameter providing clearances as required below. Coordinate the required opening sizes with the manufacturer of the fire protection products.

1. Uninsulated pipe penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each uninsulated pipe.
2. Insulated pipes penetrations through non-rated walls and floors: pipe penetration sizes shall be a 1” (minimum) to 2” (maximum) larger than the outside diameter of each pipe, including insulation.
3. Uninsulated pipe penetrations through fire rated walls and floors, and through roof: penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than the outside diameter of each uninsulated pipe to provide minimum 1/4” annular space between the outside of the pipe surface and assembly. Coordinate with specific manufacturer requirements and UL listing.
4. Insulated pipe penetrations through fire rated walls and floors, and through roof: pipe penetration sizes shall be a 1/2” (minimum) to 1-1/2” (maximum) larger than

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the outside diameter of each insulated pipe to provide minimum 1/4” annular space between the outside of the insulation surface and assembly. Coordinate with specific manufacturer requirements and UL listing.

5. Uninsulated pipe penetrations through foundation and basement walls: penetration sizes shall be larger than the outside diameter of each uninsulated pipe to allow adequate space for installation of mechanical link seals. Coordinate with specific manufacturer requirements.

3.6 ELECTRICAL COORDINATION

A. Division 23 installers shall coordinate with Division 26 work to provide complete systems as required to operate all mechanical devices installed under this Division of work.

B. Installation of Electrical Connections: Furnish, install, and wire (except as may be otherwise indicated) all heating, ventilating, air conditioning, etc., motors and controls in accordance with the drawings and in accordance with equipment manufacturer’s written instructions and with recognized industry practices, and complying with applicable requirements of UL, NEC, and NECA’s “Standard of Installation” to ensure that products fulfill requirements.

C. Division 23 has responsibilities for electrically powered mechanical equipment which is specified in Division 23 Specifications or scheduled on Division 23 Drawings as follows:

1. Motors: Furnish and install all motors necessary for mechanical equipment.
2. Magnetic Starters: Furnish all magnetic starters whether manually or automatically controlled which are necessary for mechanical equipment. Furnish these starters with all control relays or transformers necessary to interface with mechanical controls. If the starter is factory installed on a piece of Division 23 equipment, also furnish and install the power wiring between starter and motor.
3. Variable Frequency Drives: Provide all VFD’s associated with mechanical equipment. If the drive is installed on a piece of factory assembled equipment the wiring between motor and drive is to be provided as part of the factory equipment.
4. Disconnects: Provide the disconnects which are part of factory wired Division 23 equipment. Factory wiring to include wiring between motor and disconnect or combination starter/disconnect.
5. Controls: Division 23 Contractor (including the Building Automation System (BAS) Controls subcontractor) is responsible for furnishing the following equipment in its entirety. This equipment includes but is not limited to the following:

    a. Additional control panels beyond what is identified on drawings shall be provided by BAS contractor in order to provide a complete control system at no additional cost to Owner. 120v wiring to these control panels shall be provided by the Contractor as coordinated by the BAS contractor from nearest source panel.
    b. Control relays necessary for controlling Division 23 equipment.
    c. Control transformers necessary for providing power to controls for Division 23 equipment.

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d. Line voltage thermostats.
e. Low or non-load voltage control components.
f. Remote bulb thermostats.
g. Non-life safety related valve or damper actuators.
h. Float switches.
i. Solenoid valves.
j. Switches.
k. Refrigeration controls.
l. Communications wiring and conduit between control devices and mechanical equipment. Control wiring gauge in stranded or solid wire configuration shall be the responsibility of the contractor to coordinate with manufacturers for allowable lengths and load requirements to assure complete and operational systems.
m. Raceway to support control cabling.

6. Fire/Smoke Dampers: Division 23 is responsible for providing and physically installing the damper and for installing any required control interface wiring to Division 23 controls.

a. Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for providing dampers with specified end switches for use by Division 28 in providing proof of closure.
b. Where fire/smoke dampers are part of an integrated smoke control system, Division 23 is responsible for installing duct detectors, provided by Division 28, in duct.
c. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed in ductwork by Division 23 but wired to the damper controller by Division 26.

D. Division 26 Electrical Responsibilities:

1. BAS Controls Contractor shall initiate and coordinate a meeting with the Electrical Contractor and General Contractor to coordinate all BAS component locations and wiring requirements prior to start of construction. All additional costs associated with lack a coordinated shall be the responsibility of the BAS Contractor at no additional cost to the Owner.
2. Additional power requirements, including conduit and wiring, for additional or relocated control panels and devices shall be coordinated and the responsibility of the BAS Controls Contractor at no additional cost to Owner.
3. Motors: Provide the power wiring for the motors from servicing panel to motor controller.
4. Magnetic Starters: Except where magnetic starters are factory installed on Division 23 factory assembled equipment, Division 26 is to install magnetic starters furnished by Division 23 and install the necessary power wiring to the starter and from the starter to the motor. In the case of factory installed starters,

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Division 26 is to install the necessary power wiring from source panel/disconnect to the starter.

5. Variable Frequency Drives: Provide the necessary power wiring to the VFD and from the VFD to the motor except in the case of factory installed VFD's where wiring between the motor and VFD is to be by Division 23.
6. Disconnects: Provide all disconnects necessary for Division 23 mechanical equipment which are not provided as part of factory wired Division 23 equipment. Provide power wiring to all disconnects. In addition, provide power wiring between motor and disconnect when the disconnect is not factory installed.
7. Controls: Division 26 is responsible for providing power to mechanical control panels and provide final power connection to Division 23 provided control transformers.
8. Fire/Smoke Dampers:
    a. Division 26 is responsible for power wiring to each damper.
    b. Where these dampers are part of an integrated smoke control system Division 28 is responsible for providing the duct\smoke detectors, for Division 23 installation in duct. Division 26 is responsible for all fire detection system wiring necessary to integrate dampers and related end switches into the system.
    c. Where these dampers are not part of an integrated area wide smoke detection system, Division 23 is responsible for providing each fire/smoke damper with a dedicated duct smoke detector installed per the requirements of the building code. If not integral with the damper assembly, the detector is to be installed by Division 23, but wired for damper control by Division 26.

E. Motors and Motor Control Equipment: Conform to the standards of the NEMA. Equip motors with magnetic or manual line starters with overload protection. Motor starters and line voltage controls shall be installed under Electrical Section but located and coordinated as required under this Section of the work. Starters shall be combination type with non-fusible disconnect switches. All single phase fractional horsepower motors shall have built-in overload protection.

3.7 FIELD PAINTING

A. All painting shall be provided under this Division work, unless otherwise specified under Section 099100: Painting. Painting schemes shall comply with ANSI A13.1.

B. Paint all exposed materials such as piping, framing, supports, black steel, ductwork, equipment, insulation, galvanized steel, etc. The inside surface of visible ductwork above diffusers/grilles/registers shall be painted flat black.

C. All exposed work under Division 23 shall receive either a factory finish or a field prime coat finish, except:

1. Exposed copper piping.
2. Exposed stainless steel.
3. Exposed aluminum.
4. Aluminum jackets installed over outdoor insulation.

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3.8 FACTORY PAINTING

A. Manufacturer's standard factory painting systems may be provided subject to certification that the factory painting system applied will withstand 125 hours in a salt-spray fog test, except that equipment located outdoors must withstand 500 hours in a salt-spray fog test. Salt-spray fog test must be in accordance with ASTM B117, and for that test the acceptance criteria must be as follows: immediately after completion of the test, the paint must show no signs of blistering, wrinkling, or cracking, and no loss of adhesion; and the specimen must show no signs of rust creepage beyond 3 mm 0.125 inch on either side of the scratch mark. The film thickness of the factory painting system applied on the equipment must not be less than the film thickness used on the test specimen. If manufacturer's standard factory painting system is being proposed for use on surfaces subject to temperatures above 120°F (50°C), the factory painting system must be designed for the temperature service.

3.9 IDENTIFICATION MARKERS

A. General: Where identification is to be applied to surfaces which require insulation, painting, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Piping System Identification:

1. Install pipe markers on each system indicated to receive identification, and include arrows to show normal direction of flow.
2. Locate pipe markers as follows:
    a. Near each valve and control device.
    b. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
    c. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
    d. At access doors, manholes, and similar access points which permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Spaced horizontally at maximum spacing of 20' along each piping run, with minimum of one in each room.
    g. Vertically spaced at each story traversed.
3. The termination of concealed condensate piping shall be marked to indicate whether the piping is connected to the primary or secondary drain.

C. Ductwork Identification: A minimum of every 50' for all ductwork, 12" or more in diameter or width, where ducts are concealed above accessible ceilings.

D. Mechanical Equipment Identification: Locate engraved plastic laminate signs on or near each major item of mechanical equipment and each operational device. Provide signs for the following:

1. Main control and operating valves, including safety devices.

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2. Meters, gauges, thermometers, and similar units.
3. Pumps.
4. Chillers.
5. Boilers.
6. Fans.
7. Compressors and similar motor-driven units.
8. Hot water system mixing valves and similar equipment.
9. Heat exchangers and similar equipment.
10. Balancing dampers and mixing boxes.
11. Packaged HVAC central-station and zone-type units.
12. Tanks and pressure vessels.
13. Strainers, filters, treatment systems and similar equipment.

E. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations. Equipment signs shall include an identification of the area or other equipment served by the equipment being labeled.

F. Underground Piping Identification: During backfilling/topsoiling of each exterior underground piping system, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

3.10 VIBRATION AND DYNAMIC BALANCING

A. All equipment submitted and installed by Division 23 shall not exceed maximum tolerances as specified by the “International Research and Development Corporation”, Worthington, Ohio, measured by the displacement, peak to peak, as follows:

1. All Fans: Below severity chart labeled “FAIR”, maximum velocity of 0.0786 in/sec, peak.
2. Pump and Electric Motors: Below severity chart labeled “SLIGHTLY ROUGH”, maximum vibration velocity of 0.157 in/sec, peak.
3. Compressors: Same as pumps.

B. Where installed equipment noise or vibration is objectionable to the Owner’s Representative, it shall be responsibility of the contractor to conduct testing to confirm that the equipment does not exceed the standard.

C. Correction shall be made to all equipment, which exceeds vibration tolerances specified above. Final vibration levels shall be reported as described above.

3.11 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. Upon completion of testing, certify to the Owner’s Representative, in writing, that the specified tests have

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been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Ductwork: Test all air quantities as specified in Section 230593 - Testing, Adjusting and Balancing. Pressure tests per SMACNA.

C. Registers and Diffusers: Test for proper operation of manually operated control feature. Test all air quantities as specified in Section 230593 – Testing, Adjusting and Balancing.

D. Ductwork Specialties: Test all operable ductwork specialties for proper operation. Check all fire, smoke and fire/smoke dampers to ensure that they are 100% open.

E. Temperature Control: Test all control functions to assure that all systems are controlling as specified or as otherwise necessary and that all controls are adjusted to maintain proper room temperatures. The manufacturer's representative shall perform all tests.

END OF SECTION 230500

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