

**SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC**

PART 1 - GENERAL

1. DEFINITIONS:

- A. Exposed: Piping, ductwork, and equipment exposed to view in finished rooms.
- B. Option or optional: Contractor's choice of an alternate material or method.

2. RELATED WORK

- A. The requirements of this section relate to all Division 23 sections included with this project.

3. QUALITY ASSURANCE

- A. Mechanical, electrical and associated systems shall be safe, reliable, efficient, durable, easily and safely operable and maintainable, easily and safely accessible, and in compliance with applicable codes as specified. The systems shall be comprised of high quality commercial class products from manufacturers that are experienced specialists in the required product lines. All construction firms and personnel shall be experienced and qualified specialists in commercial HVAC systems.
- B. After HVAC air balance work is completed and permanent drive sheaves are in place, perform field mechanical balancing and adjustments required to meet the specified vibration tolerance.
- C. Products Criteria:
 - 1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least 3 years (or longer as specified elsewhere). The design, model and size of each item shall have been in satisfactory and efficient operation on at least three installations for approximately three years. However, digital electronics devices, software and systems such as controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years. See other specification sections for any exceptions and/or additional requirements.
 - 2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
 - 3. Conform to codes and standards required by the specifications. Conform to local codes where local codes are more stringent than those specified. Refer any conflicts to the Project Engineer.
 - 4. Multiple Units: When two or more units of materials or equipment of the same type or class are required, these units shall be products of one manufacturer.
 - 5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.

6. Nameplates: Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
 7. Asbestos products or equipment or materials containing asbestos shall not be used.
- D. Equipment Service Organizations:
1. HVAC: Products and systems shall be supported by service organizations that maintain a complete inventory of repair parts and have factory certified technicians on staff.
- E. HVAC Mechanical Systems Welding: Before any welding is performed, Contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".
 2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
 3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
- F. Execution (Installation, Construction) Quality:
1. Apply and install all items in accordance with manufacturer's written instructions. Refer conflicts between the manufacturer's instructions, the contract drawings and specifications to the Project Engineer for resolution.
 2. Provide complete layout drawings required by Paragraph, SUBMITTALS. Do not commence construction work on any system until the layout drawings have been approved.

4. WARRANTIES

- A. All equipment, materials and workmanship shall be warrantied against defect for a period of (1) year from the date of substantial completion. Warranties listed herein shall cover the costs associated with the repair or replacement of the defective item or system within a reasonable timeframe.
- B. Refrigeration compressors shall be warrantied against defect or failure for a period of (5) years from the date of substantial completion. This warranty shall cover the cost of all parts and labor during the warranty period and equipment shall be repaired or replaced at no cost to the owner in a reasonable timeframe.

5. DRAWINGS

- A. The drawings as included as a part of the Construction Document package are diagrammatic in nature. They are meant to convey design intent and are not meant to be absolute in their content. It shall be the responsibility of the installing Contractor to ensure that all equipment, materials, components and labor are provided required for a fully functional, code compliant system in accordance with the design intent. Should questions arise or additional clarity be required, the Contractor shall issue an RFI in

written format to the prime design professional. Written communication will be the only form of correspondence between the design and construction teams and will be the only format by which changes, modifications or clarifications will be formally issued and is the only means by which the Construction Documents will be modified.

6. SUBMITTALS

- A. Contractor shall make all field measurements and investigations to assure that the equipment and assemblies will meet the intent of the Construction Documents. Contractor to ensure that all manufacturer or code required clearances are maintained for all installed equipment. Submittals shall be made as a single submission no later than 45 days after award of Construction Contract and shall be reviewed and approved by the project General Contractor or CM prior to submitting for approval. Approval of shop drawings or submittals does not constitute an acceptance from the Design Team and does not modify the Contractor's responsibility to provide equipment, materials and workmanship in accordance with the intent of the Construction Documents. Further, approval does not modify the requirement for the Contractor to provide equipment, materials and workmanship as indicated in the contract documents whether it is indicated or discovered in the submittal review process or not. Contractor shall be responsible for providing all equipment, materials and workmanship in accordance with the Construction Documents regardless of level of approval.
- B. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract documents. This Contractor shall be responsible for the cost associated with all modifications required as a result of equipment or material substitutions. This shall include the cost associated with all electrical, plumbing, structural and architectural modifications required as a result of the substitution. The Architect and Engineer of Record shall be duly compensated for the cost associated with making these modifications and updating the construction drawings accordingly. Shop drawing or submittal approval does not relinquish the Contractor from the responsibility of providing equipment, materials and workmanship in accordance with the general intent of the Construction Documents and in compliance with all codes and standards in effect at the time of construction. In cases where there is confusion or there appears to be conflicting information contained within the Construction Documents, the Architect or Engineer of Record shall be consulted through the RFI process and shall make the final determination as to the intent of the Construction Documents. The Contractor shall proceed with the construction process in accordance with the interpretation of the Architect or Project Engineer at no additional cost to the owner or project.
- C. Prior to submitting shop drawings for approval, Contractor shall ensure that manufacturers or vendors of all equipment have each reviewed drawings and specifications and have jointly coordinated and properly integrated their equipment and controls to provide a complete, functional, efficient and code compliant installation in accordance with the intent of the Construction Documents.

- D. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible installation.
- E. Coordination Drawings:
 - 1. Submit complete coordinated layout drawings for all new systems, existing systems to be modified and for existing systems that are in the same areas. Coordination drawings shall include all relevant building systems required to demonstrate a coordinated installation. This shall include all HVAC, electrical, plumbing, structural, architectural and low voltage systems scheduled for installation or modification. **Failure for the Contractor to submit the required coordination drawings shall indicate that the Contractor has taken full responsibility for the cross-discipline coordination effort and is proceeding completely at his own risk. General Contractor shall list this qualification in its Construction Contract.** Should the Architect, Engineer or Authority Having Jurisdiction identify any installation, functional, clearance or compliance issues during field observations, the Contractor shall provide for remedy of the identified issues completely at his own cost.
 - 2. The coordination drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1/8 inch per foot. Clearly identify and dimension the locations of the principal items of equipment and building systems. The drawings shall clearly show locations and adequate clearance for all equipment, piping, ducting, valves, control panels and other items. Show the access means for all items requiring access for operations and maintenance. Provide detailed layout drawings of all piping and duct systems to include all materials, fittings, elbows, access doors, accessories, dampers, and control elements.
 - 3. Do not install equipment foundations, equipment or piping until layout drawings have been approved.
 - 4. In addition, for HVAC systems, provide details of the following:
 - a) Mechanical equipment rooms.
 - b) Hangers, inserts, supports, and bracing.
 - c) Pipe sleeves.
 - d) Duct or equipment penetrations of floors, walls, ceilings, or roofs.
- F. HVAC Maintenance Data and Operating Manuals:
 - 1. Maintenance and operating manuals shall be provided with the project close-out documents.
 - 2. Provide a listing of recommended replacement parts for keeping in stock supply, including sources of supply, for equipment. Include in the listing belts for equipment: Belt manufacturer, model number, size and style.

3. Close-out documentation shall be provided to the owner at the completion of the project. Close-out documentation shall be completely contained within a binder or series of binders and shall include the approved submittals, test & balance report, manufacturer provided O&M manuals, record drawings, start-up reports, warranty registrations, warranty contact information, maintenance/repair contact information and complete operating instructions. In addition to the required binders, a complete copy of the close-out documents shall be provided in PDF format on DVD. Unless otherwise noted in the front-end documents or as requested by the owner, a total of (3) sets of close-out documents shall be provided at the completion of the construction process.
- G. Provide copies of approved HVAC equipment submittals to the Testing, Adjusting and Balancing SubContractor.
- H. Record Documents:
 1. Field changes and RFI responses shall be kept with a copy of the Contract Documents on site. Contractor shall prepare Record Documents using the latest versions of either AutoCAD or REVIT (depending on the software used in the design process) and shall indicate any modifications made during the construction process. An electronic copy of all Record Documents shall be provided to the Design Team in either (.dwg) format or (.rvt) format upon completion. Both full size printed copies and electronic copies of the record drawings shall be provided with the close-out document package. Electronic files shall be stored on DVD and shall be provided with the project close-out documents and shall be provided in PDF format.
- I. All close-out documents must be received by the owner and electronic files received by the Design Team prior to approval and release of the final pay-application.

7. APPLICABLE CODES AND STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning, Heating and Refrigeration Institute (AHRI)
- C. American National Standard Institute (ANSI)
- D. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- E. National Fire Protection Association (NFPA)
- F. International Building Code (IBC) and all relevant sections.
- G. All enforced local codes, standards and amendments.

8. DELIVERY, STORAGE AND HANDLING

- A. Protection of Equipment:
 - 1. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the owner has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of such equipment and material against any damage.
 - 2. Place damaged equipment in first class, new operating condition; or, replace same as determined and directed by the Resident Engineer. Such repair or replacement shall be at no additional cost to the owner.
 - 3. Protect interiors of new equipment and piping systems against entry of foreign matter. Clean both inside and outside before painting or placing equipment in operation.
 - 4. Existing equipment and piping being worked on by the Contractor shall be under the custody and responsibility of the Contractor and shall be protected for new work.
- B. Cleanliness of Piping and Equipment Systems:
 - 1. Exercise care in storage and handling of equipment and piping material to be incorporated in the work. Remove debris arising from cutting, threading and welding of piping.
 - 2. Piping systems shall be flushed, blown or pigged to deliver clean systems.
 - 3. Clean interior of all tanks prior to delivery for beneficial use by the owner.
 - 4. Boilers shall be left clean following final internal inspection by owner insurance representative or inspector.
 - 5. Contractor shall be fully responsible for all costs, damage, and delay arising from failure to provide clean systems.
 - 6. Existing equipment indicated for reuse will be inspected, cleaned and repaired to return to service.

PART 2 - PRODUCTS

1. FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies that include components made by others shall assume complete responsibility for final assembled unit.
- C. All components of an assembled unit need not be products of same manufacturer.
 - 1. Constituent parts that are alike shall be products of a single manufacturer.
 - 2. Components shall be compatible with each other and with the total assembly for intended service.
 - 3. Contractor shall guarantee performance of assemblies of components and shall repair or replace elements of the assemblies to deliver specified performance of the complete assembly.

- D. Components of equipment shall bear manufacturer's name and trademark, model number, serial number and performance data on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- E. Major items of equipment, which serve the same function, must be the same make and model. Exceptions will be permitted if performance requirements cannot be met.

2. COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

3. ELECTRIC MOTORS

- A. All material and equipment furnished and installation methods shall conform to the requirements of Section 23 05 12, GENERAL MOTOR REQUIREMENTS and the associated electrical sections. Provide all electrical wiring, conduit, and devices for the proper connection, protection and operation of the systems. Provide special energy efficient premium efficiency type motors.
- B. Variable speed motor controllers
 - 1. The combination of controller and motor shall be provided by the manufacturer of the driven equipment, such as pumps and fans, and shall be rated for 100 percent output performance. Multiple units of the same class of equipment, i.e. air handlers, fans, pumps, shall be product of a single manufacturer.
 - 2. Motors shall be premium efficiency type and be approved by the motor controller manufacturer. The controller-motor combination shall be guaranteed to provide full motor nameplate horsepower in variable frequency operation. Both driving and driven motor fan sheaves shall be fixed pitch.
 - 3. Controller shall not add any current or voltage transients to the input AC power distribution system, DDC controls, sensitive medical equipment, etc., nor shall be affected from other devices on the AC power system.
 - 4. Controller shall be provided with the following operating features and accessories:
 - a) Suitable for variable torque load.
 - b) Provide thermal magnetic circuit breaker with external operator and incoming line fuses. Unit shall be rated for minimum 30,000 AIC. Provide AC input line reactors (3% Impedance) on incoming power line. Provide output line reactors on line between drive and motor for motors over 50 HP or where the distance between the breaker and motor exceeds 50 feet.

4. EQUIPMENT AND MATERIALS IDENTIFICATION

- A. Use symbols, nomenclature and equipment numbers specified, shown on the drawings and shown in the maintenance manuals.
- B. Interior (Indoor) Equipment: Engraved nameplates, with letters not less than 3/16-inch high of brass with black-filled letters, or rigid black plastic with white letters permanently fastened to the equipment. Identify unit components such as coils, filters, fans, etc. Label disconnects, motor control centers, control panels and VFDs.
- C. Exterior (Outdoor) Equipment: Brass nameplates, with engraved black filled letters, not less than 3/16-inch high riveted or bolted to the equipment.
- D. Control Items: Label all temperature and humidity sensors, controllers and control dampers. Identify and label each item as they appear on the control diagrams.
- E. Piping: Label all piping with color-coded bands and permanent tags indicating the system type and direction of flow for the piping system. Pipe markers, letter size and color designations shall be per ANSI/ASME A13.1 Scheme for the Identification of Piping Systems.
- F. Valve Tags and Lists:
 - 1. Valve tags: Engraved black filled numbers and letters not less than 1/2-inch high for number designation, and not less than 1/4-inch for service designation on 19 gage 1-1/2 inches round brass disc, attached with brass "S" hook or brass chain.
 - a) Valve lists: Typed or printed plastic coated card(s), sized 8-1/2 inches by 11 inches showing tag number, valve function and area of control, for each service or system.
 - b) Provide detailed plan for each floor of the building indicating the location and valve number for each valve. Identify location of each valve with a color coded thumb tack in ceiling.

5. HVAC PIPE AND EQUIPMENT SUPPORTS AND RESTRAINTS

- A. Supports for Roof Mounted Items:
 - 1. Equipment Pre-fabricated curbs (when not provided by manufacturer): Galvanized steel or extruded aluminum 14 inches above finish roof service, continuous welded corner seams, treated wood nailer (1-1/2 inch thick), 3 pound/cubic feet density rigid mineral fiberboard insulation with metal liner, built-in cant strip (except for gypsum or tectum decks). For surface insulated roof deck, provide raised cant strip (recessed mounting flange) to start at the upper surface of the insulation. Curbs shall be constructed for pitched roof or ridge mounting to keep top of curb level. Pipe/duct pedestals: Provide a galvanized Unistrut channel welded to U-shaped mounting brackets which are secured to side of rail with galvanized lag bolts.
 - 2. Pipe Supports: Comply with MSS SP-58. Type Numbers specified refer to this standard.

3. Attachment to Concrete Building Construction:
 - a) Concrete insert: MSS SP-58, Type 18.
 4. Attachment to Steel Building Construction:
 - a) Welded attachment: MSS SP-58, Type 22.
 - b) Beam clamps: MSS SP-58, Types 20, 21, 28 or 29. Type 23 C-clamp may be used for individual copper tubing up to 7/8-inch outside diameter.
 5. Hanger Rods: Hot-rolled steel, ASTM A36 or A575 for allowable load listed in MSS SP-58. For piping, provide adjustment means for controlling level or slope. Types 13 or 15 turn-buckles shall provide 1-1/2 inches minimum of adjustment and incorporate locknuts. All-thread rods are acceptable.
 6. Hangers Supporting Multiple Pipes (Trapeze Hangers): Galvanized, cold formed, lipped steel channel horizontal member, not less than 1-5/8 inches by 1-5/8 inches, No. 12 gage, designed to accept special spring held, hardened steel nuts. Not permitted for steam supply and condensate piping.
 - a) Allowable hanger load: Manufacturers rating less 200 pounds.
 - b) Guide individual pipes on the horizontal member of every other trapeze hanger with 1/4-inch U-bolt fabricated from steel rod. Provide Type 40 insulation shield, secured by two 1/2-inch galvanized steel bands or pre-insulated calcium silicate shield for insulated piping at each hanger.
- B. Supports for Piping Systems:
1. Select hangers sized to encircle insulation on insulated piping. Refer to Mechanical Insulation spec section for insulation thickness. To protect insulation, provide Type 39 saddles for roller type supports or pre-insulated calcium silicate shields. Provide Type 40 insulation shield or pre-insulated calcium silicate shield at all other types of supports and hangers including those for pre-insulated piping.
- C. Piping Systems except High and Medium Pressure Steam (MSS SP-58):
1. Standard clevis hanger: Type 1; provide locknut.
 2. Riser clamps: Type 8.
 3. Wall brackets: Types 31, 32 or 33.
 4. Roller supports: Type 41, 43, 44 and 46.
 5. Saddle support: Type 36, 37 or 38.
 6. Turnbuckle: Types 13 or 15. Pre-insulate.
 7. U-bolt clamp: Type 24.
 8. Copper Tube:
 - a) Hangers, clamps and other support material in contact with tubing shall be painted with copper colored epoxy paint, plastic coated or taped with non-adhesive isolation tape to prevent electrolysis.
 - b) For vertical runs use epoxy painted or plastic coated riser clamps.
 - c) For supporting tube to strut: Provide epoxy painted pipe straps for copper tube or plastic inserted vibration isolation clamps.
 - d) Insulated Lines: Provide pre-insulated shields sized for copper tube.

- e) Supports for plastic or glass piping: As recommended by the pipe manufacturer with black rubber tape extending one inch beyond steel support or clamp.

6. PIPE PENETRATIONS

- A. Install sleeves during construction for other than blocked out floor openings for risers.
- B. To prevent accidental liquid spills from passing to a lower level, provide the following:
 - 1. For sleeves: Extend sleeve one inch above finished floor and provide sealant for watertight joint.
 - 2. For blocked out floor openings: Provide 1-1/2 inch angle set in silicone adhesive around opening.
 - 3. For drilled penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
 - 4. Penetrations are not allowed through beams or ribs, but may be installed in concrete beam flanges. Any deviation from these requirements must receive prior approval of the Architect.
 - 5. Sheet Metal, Plastic, or Moisture-resistant Fiber Sleeves: Provide for pipe passing through floors, interior walls, and partitions, unless brass or steel pipe sleeves are specifically called for below.
 - 6. Cast Iron or Zinc Coated Pipe Sleeves: Provide for pipe passing through exterior walls below grade. Make space between sleeve and pipe watertight with a modular or link rubber seal. Seal shall be applied at both ends of sleeve.
 - 7. Galvanized Steel or an alternate Black Iron Pipe with asphalt coating Sleeves: Provide for pipe passing through concrete beam flanges, except where brass pipe sleeves are called for. Provide sleeve for pipe passing through floor of mechanical rooms, laundry work rooms, and animal rooms above basement. Except in mechanical rooms, connect sleeve with floor plate.
 - 8. Sleeve Clearance: Sleeve through floors, walls, partitions, and beam flanges shall be one inch greater in diameter than external diameter of pipe. Sleeve for pipe with insulation shall be large enough to accommodate the insulation. Interior openings shall be caulked tight with fire stopping material and sealant to prevent the spread of fire, smoke, and gases.

7. DUCT PENETRATIONS

- A. Provide curbs for roof mounted piping, ductwork and equipment. Curbs shall be 18 inches high with continuously welded seams, built-in cant strip, interior baffle with acoustic insulation, curb bottom, hinged curb adapter.
- B. Provide firestopping for openings through fire and smoke barriers, maintaining minimum required rating of floor, ceiling or wall assembly.

8. WALL, FLOOR AND CEILING PLATES

- A. Material and Type: Chrome plated brass or chrome plated steel, one piece or split type with concealed hinge, with set screw for fastening to pipe, or sleeve. Use plates that fit tight around pipes, cover openings around pipes and cover the entire pipe sleeve projection.
- B. Locations: Use where pipe penetrates floors, walls and ceilings in exposed locations, in finished areas only. Provide a watertight joint in spaces where brass or steel pipe sleeves are specified.

9. ASBESTOS

- A. Materials containing asbestos are not permitted.

PART 3 - EXECUTION

1. ARRANGEMENT AND INSTALLATION OF EQUIPMENT AND PIPING

- A. Coordinate location of piping, sleeves, inserts, hangers, ductwork and equipment with other trades. Locate piping, sleeves, inserts, hangers, ductwork and equipment clear of windows, doors, openings, lights and other services and utilities. Prepare equipment layout drawings to coordinate proper location and personnel access of all facilities. Follow manufacturer's published recommendations for installation methods not otherwise specified.
- B. Operating Personnel Access and Observation Provisions: Select and arrange all equipment and systems to provide clear view and easy access for maintenance and operation of all devices including, but not limited to: all equipment items, valves, filters, strainers, transmitters, sensors and control devices. All gages and indicators shall be clearly visible by personnel standing on the floor or on permanent platforms. Do not reduce or change maintenance and operating space and access provisions that are shown on the drawings.
- C. Equipment and Piping Support: Coordinate structural systems for pipe and equipment support with pipe and equipment locations to permit proper installation.
- D. Location of pipe sleeves, trenches and chases shall be accurately coordinated with equipment and piping locations.
- E. Cutting Holes:
 - 1. Locate holes to avoid interference with structural members such as beams or grade beams. Holes shall be laid out in advance for coordination purposes. If the Contractor considers it to drill through structural members, this matter shall be referred to the Architect or Structural Engineer for approval.
 - 2. Do not penetrate membrane waterproofing.

- F. Interconnection of Instrumentation or Control Devices: Generally, electrical interconnections are not shown but must be provided.
- G. Minor Piping: Generally, small diameter pipe runs from drips and drains, water cooling, and other service are not shown but must be provided.
- H. Electrical Interconnection of Controls and Instruments: This is generally not shown but must be provided. This includes interconnections of sensors, transmitters, transducers, control devices, control and instrumentation panels, instruments and computer workstations. Comply with NFPA-70.
- I. Protection and Cleaning:
 - 1. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in accordance with the manufacturer's recommendations. Damaged or defective items, in the opinion of the Architect or Project Engineer, shall be replaced.
 - 2. Protect all finished parts of equipment, such as shafts and bearings where accessible, from rust prior to operation by means of protective grease coating and wrapping. Close pipe openings with caps or plugs during installation. Tightly cover and protect fixtures and equipment against dirt, water chemical or mechanical injury. At completion of all work thoroughly clean fixtures, exposed materials and equipment.
- J. Install gages, thermometers, valves and other devices with due regard for ease in reading or operating and maintaining said devices. Locate and position thermometers and gages to be easily read by operator or staff standing on floor or walkway provided. Servicing shall not require dismantling adjacent equipment or pipe work.
- K. Install steam piping expansion joints as per manufacturer's recommendations.
- L. Switchgear/Electrical Equipment Drip Protection: Every effort shall be made to eliminate the installation of pipe above electrical equipment. If this is not possible, encase pipe in a second pipe with a minimum of joints and provide a baffle above the electrical equipment sloped to ensure water will run-off away from the electrical equipment. Installation of piping, ductwork, leak protection apparatus or other installations foreign to the electrical installation shall be located in the space equal to the width and depth of the equipment and extending from to a height of 6 ft. above the equipment or to the ceiling structure, whichever is lower (NFPA 70).
- M. Inaccessible Equipment:
 - 1. Equipment shall be installed with access clearance and access service panels per section 306 of the International Mechanical Code, National Electric Code and manufacturer's instructions, whichever is the most stringent. Equipment access shall be provided so that equipment may be removed without removing elements of permanent construction (gypsum board ceilings, plumbing piping, etc.).

2. Where the Architect or Project Engineer determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled or remedial action performed as directed at no additional cost to the owner.
3. The term "conveniently accessible" is defined as capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, fans, pumps, belt guards, transformers, high voltage lines, piping, and ductwork.

2. TEMPORARY SYSTEMS AND EQUIPMENT

- A. Where required by the Construction Documents, temporary systems shall be provided to match the capacity of the systems being modified to ensure continuous operations of the space. Temporary systems shall be capable of maintaining the spaces temperature between 45 degrees F and 80 degrees F and 60% relative humidity maximum.
- B. Continuity of operation of existing facilities will generally require temporary installation or relocation of equipment and piping.
- C. The Contractor shall provide all required facilities in accordance with the requirements of phased construction and maintenance of service. All piping and equipment shall be properly supported, sloped to drain, operate without excessive stress and shall be insulated where injury can occur to personnel by contact with operating facilities.
- D. Temporary facilities and piping shall be completely removed and any openings in structures sealed/finished to match existing. Provide blind flanges and caps to seal open piping remaining in service.

3. RIGGING

- A. Design is based on application of available equipment. Openings in building structures are planned to accommodate design scheme.
- B. Alternative methods of equipment delivery may be offered by Contractor and will be considered by the owner under specified restrictions of phasing and maintenance of service as well as structural integrity of the building.
- C. Close all openings in the building when not required for rigging operations to maintain proper environment in the facility for owner operation and maintenance of service.
- D. Contractor shall provide all facilities required to deliver specified equipment and place on foundations. Attachments to structures for rigging purposes and support of equipment on structures shall be Contractor's full responsibility.
- E. Contractor shall check all clearances, weight limitations and shall offer a rigging plan designed by a Registered Professional Engineer. All modifications to structures, including reinforcement thereof, shall be at Contractor's cost, time and responsibility.

- F. Restore building and surroundings to original condition upon completion of rigging work.

4. PIPE AND EQUIPMENT SUPPORTS

- A. Where hanger spacing does not correspond with joist or rib spacing, use structural steel channels secured directly to joist and rib structure that will correspond to the required hanger spacing, and then suspend the equipment and piping from the channels. Drill or burn holes in structural steel only with the prior approval of the Architect or Structural Engineer.
- B. Use of chain, wire or strap hangers; wood for blocking, stays and bracing; or, hangers suspended from piping above will not be permitted. Replace or thoroughly clean rusty products and paint with zinc primer.
- C. Use hanger rods that are straight and vertical. Turnbuckles for vertical adjustments may be omitted where limited space prevents use. Provide a minimum of 1/2-inch clearance between pipe or piping covering and adjacent work.
- D. HVAC Horizontal Pipe Support Spacing: Refer to MSS SP-69 and relevant codes. Provide additional supports at valves, strainers, in-line pumps and other heavy components. Provide a support within one foot of each elbow.
- E. HVAC Vertical Pipe Supports:
 - 1. Up to 6-inch pipe, 30 feet long, bolt riser clamps to the pipe below couplings or welded to the pipe and rests supports securely on the building structure.
 - 2. Vertical pipe larger than the foregoing, support on base elbows or tees, or substantial pipe legs extending to the building structure.
- F. Overhead Supports:
 - 1. Contractor shall confirm that the basic structural system of the building is designed to sustain the loads imposed by equipment and piping to be supported overhead.
 - 2. Provide steel structural members, in addition to those shown, of adequate capability to support the imposed loads, located in accordance with the final approved layout of equipment and piping.
- G. Floor Supports:
 - 1. Provide concrete bases, concrete anchor blocks and pedestals, and structural steel systems for support of equipment and piping. Anchor and dowel concrete bases and structural systems to resist forces under operating conditions, seismic conditions (if applicable), and to withstand design wind pressures without excessive displacement or structural failure.

2. Do not locate or install bases and supports until equipment mounted thereon has been approved. Size bases to match equipment plus 3 inch excess on all edges. Boiler foundations shall have horizontal dimensions that exceed boiler base frame dimensions by at least 6 inches on all sides. Refer to structural drawings. Bases shall be neatly finished and smoothed, shall have chamfered edges at the top, and shall be suitable for painting.
3. All equipment shall be shimmed, leveled, firmly anchored, and grouted with epoxy grout. Anchor bolts shall be placed in sleeves, anchored to the bases. Fill the annular space between sleeves and bolts with a granular material to permit alignment and realignment.

5. CLEANING AND PAINTING

- A. Prior to final inspection and acceptance of the facilities for beneficial use by the owner, the facilities, equipment and systems shall be thoroughly cleaned and painted.
- B. In addition, the following special conditions apply:
 1. Cleaning shall be thorough. Use solvents, cleaning materials and methods recommended by the manufacturers for the specific tasks. Remove all rust prior to painting and from surfaces to remain unpainted. Repair scratches, scuffs, and abrasions prior to applying prime and finish coats.
- C. Material And Equipment Not To Be Painted Includes:
 1. Motors, controllers, control switches, and safety switches.
 2. Control and interlock devices.
 3. Regulators.
 4. Pressure reducing valves.
 5. Control valves and thermostatic elements.
 6. Lubrication devices and grease fittings.
 7. Copper, brass, aluminum, stainless steel and bronze surfaces.
 8. Valve stems and rotating shafts.
 9. Pressure gauges and thermometers.
 10. Glass.
 11. Name plates.
- D. Control and instrument panels shall be cleaned, damaged surfaces repaired, and shall be touched-up with matching paint obtained from panel manufacturer.
- E. Pumps, motors, steel and cast iron bases, and coupling guards shall be cleaned, and shall be touched-up with the same color as utilized by the pump manufacturer
- F. Temporary Facilities: Apply paint to surfaces that do not have existing finish coats.
- G. Final result shall be smooth, even-colored, even-textured factory finish on all items. Completely repaint the entire piece of equipment to achieve this.

- H. Any exposed piping, ducting or equipment shall be completely painted. Colors shall be consistent with industry standards or as the owner wishes. All exterior equipment, piping or ducting shall be painted with a corrosion resistant finish compatible with the painted material and as recommended by the manufacturer.

6. MOTOR AND DRIVE ALIGNMENT

- A. Belt Drive: Set driving and driven shafts parallel and align so that the corresponding grooves are in the same plane. Provide belt and sheave replacements to achieve test and balance at no additional cost to project.
- B. Direct-connect Drive: Securely mount motor in accurate alignment so that shafts are free from both angular and parallel misalignment when both motor and driven machine are operating at normal temperatures.

7. LUBRICATION

- A. Lubricate all devices requiring lubrication prior to initial operation. Field-check all devices for proper lubrication.
- B. All lubrication points shall be accessible without disassembling equipment, except to remove access plates.

8. STARTUP AND TEMPORARY OPERATION

- A. Start-up equipment as described in equipment specifications. All HVAC equipment shall be provided with factory start-up performed by the equipment manufacturer. Start-up sheets shall be included with the close-out documentation. Verify that vibration is within specified tolerance prior to extended operation.

9. OPERATING AND PERFORMANCE TESTS

- A. Should evidence of malfunction in any tested system or piece of equipment or component part thereof occur during or as a result of tests, make proper corrections, repairs or replacements, and repeat tests at no additional cost to the owner.
- B. When completion of certain work or system occurs at a time when final control settings and adjustments cannot be properly made prior to performance tests, performance tests for heating and cooling systems shall be completed during first actual seasonal use of respective systems following completion of work.

END OF SECTION 23 05 00