

**SECTION 23 05 29**  
**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

**PART 1 - GENERAL**

**1.1 STIPULATIONS**

- A. The specifications sections "General Conditions to the Construction Contract", "Special Conditions" and "Division 01 - General Requirements" form a part of this Section by this reference thereto, and shall have the same force and effect as if printed herewith in full.

**1.2 ADDITIONAL RELATED DOCUMENTS**

- A. Additional related Division 23 Sections include the following:
  - 1. "Common Work Results for HVAC" for metal fabrications for pipe and equipment supports.
  - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors, and piping riser spring supports.
  - 3. Division 23 Section "Vibration Controls for HVAC" for equipment and piping systems requiring vibration isolation hangers and supports.
  - 4. "Ductwork" for duct hangers and supports.
  - 5. Various other Division 23 Sections where exterior equipment is specified to be factory designed and constructed with an integral wind resistance rating.

**1.3 SUMMARY**

- A. This Section includes hangers and supports for HVAC system piping and equipment, and delegated design and engineering.
- B. This Section also includes delegated design requirements for wind restraints for exterior piping, and equipment.

**1.4 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
- B. Terminology: As defined in ANSI / MSS SP-58.

**1.5 PERFORMANCE REQUIREMENTS**

- A. Design channel support systems for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents, and test water.
- B. Design heavy-duty steel trapezes for piping to support multiple pipes capable of supporting the combined weight of supported systems, system contents, and test water.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
- B. Delegated Design Calculations and Shop Drawings: The Division 23 Contractor shall provide fabrication and installation drawings and include load and stress analyses calculations, signed and sealed by a professional engineer registered in Pennsylvania for the following:
  - 1. Pipe hangers and supports for piping where two or more pipes are routed in parallel within the same structural bay, with each sized at 2 inches or larger.
  - 2. Channel and trapeze type supports.
  - 3. Equipment supports.
  - 4. Pipeline anchors and guides.
  - 5. Wind-Restraint Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the building structural system. Show attachment locations, methods, materials, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind events. For equipment, provide dimensioned outline drawings of the unit, identify the center of gravity, and locate and describe mounting and anchoring provisions. Indicate association and coordination with vibration isolation devices. Comply with requirements in other Sections for equipment mounted outdoors.
    - a. Design Analysis: To support selection and arrangement of wind restraints for exterior piping and equipment. Include calculations of combined tensile and shear loads. Calculate static and dynamic loading due to equipment weight, operation, and wind forces required to select wind restraints.
      - 1) Wind-Restraint Loading: Comply with ASCE Standard 7 (2016), as per the project location, Exposure Category B, and a Building Risk Category of III. Design restraints for the greater of the following:
        - a) 3-Second Gust Design Wind Speed per ASCE Std. 7.
        - b) 16 lb./sq. ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.
      - 2) Importance Factor: 1.0.
      - 3) Dead weight gravity forces (except for water contained within piping) may be considered as resistance to wind forces, but friction forces shall not.
      - 4) Apply safety factors no less than 3.0.
      - 5) Restraints shall resist wind forces without damage to the restraints or the associated pipe or equipment.
      - 6) All connections are subject to the approval of the Structural Engineer of Record. The Contractor shall submit loads at each connection to the Structural Engineer of Record for approval.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Welding Certificates: Copies of certificates for welding procedures and operators.

## 1.8 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Delegated Design and Engineering Responsibility: The Division 23 Contractor is responsible for the delegated design and engineering provisions of this Section. Provide for the design and preparation of Shop Drawings and calculations for each multiple pipe support and trapeze, and equipment support, by a qualified professional engineer.
  - 1. Delegated Design Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in Pennsylvania and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent.
  - 2. The engineer providing these design services shall be the same individual providing calculations and design in accordance with the delegated design requirements of Division 23 Sections "Vibration Controls for HVAC" and "Expansion Loops for HVAC Piping". Refer to the Quality Assurance articles in these Sections for additional qualification requirements.
  - 3. The design, layout and selection of piping hangers, supports, and anchors, swing joints, and expansion fittings and loops shall comply with this specification section and Division 23 Section "Expansion Loops for HVAC Piping" shall conform to the allowable pipe stress limits defined by ASME B31.9 - Building Services Piping.
    - a. After proposed piping layouts have been established and coordinated with the other disciplines by way of the coordination drawing generation process, and have been submitted to the design Architect / Engineer an information submittal, a set of the coordination drawings shall be forwarded to the delegated design Engineer who shall in turn complete his engineering stress analysis, and shall select and design the pipe hangers, supports, expansion loops, fittings, anchors, and guides. Detailed shop drawings of piping hangers, supports, and expansion devices shall then be prepared. These shop drawings shall be stamped by the delegated design Engineer with his/her registration seal prior to submission to the design Architect / Engineer.
    - b. Comply with MSS SP-127 for bracing exterior piping against wind loads.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Pipe Hangers, Saddles, and Shields:
    - a. Anvil International, Inc.
    - b. Carpenter & Paterson, Inc.
    - c. Modern Pipe Hanger Co., Inc.
    - d. National Pipe Hanger Corp.
    - e. Penn Pipe Hanger Corp.
    - f. ERICO International Corporation.
    - g. Eaton
    - h. Walraven

- i. Or equal as approved by the Professional.
- 2. Channel Support Systems:
  - a. Anvil International, Inc.; Power-Strut Unit.
  - b. Carpenter & Paterson, Inc.
  - c. National Pipe Hanger Corp.
  - d. Thomas & Betts Corp.
  - e. Unistrut Corp.
  - f. ERICO International Corporation.
  - g. Walraven
  - h. Or equal as approved by the Professional.
- 3. Thermal-Hanger Shields and Shield Inserts:
  - a. Buckaroos Inc.
  - b. Carpenter & Paterson, Inc.
  - c. National Pipe Hanger Corp.
  - d. Pipe Shields, Inc.
  - e. Thermal Pipe Shields, Inc.
  - f. Value Engineered Products, Inc.
  - g. ERICO International Corporation.
  - h. Or equal as approved by the Professional.
- 4. Drilled-In Mechanical Fastener Systems for Concrete:
  - a. Gunnebo Fastening Corp.
  - b. Hilti, Inc.
  - c. ITW Ramset/Red Head.
  - d. Or equal as approved by the Professional.

## 2.2 MANUFACTURED UNITS

- A. Pipe Hangers, Supports, and Components: ANSI / MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.
  - 1. Galvanized, Metallic Coatings: For all piping hangers, supports, supplemental steel, hardware and accessories. All piping hangers, supports, hardware and accessories located outside shall be stainless steel or hot-dipped galvanized, no exceptions.
  - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- B. Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.
  - 1. Coatings: Manufacturer's standard finish. All channel support systems and accessories exposed to weather shall be stainless steel or hot-dipped galvanized, no exceptions.
  - 2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- C. Pipe Covering Protection Saddles: MSS Type 39, fabricated from carbon steel plate with edges rolled and ground smooth. Minimum length shall be 12". Depth of saddle shall be no less than the adjoining piping insulation thickness.

- D. Thermal-Hanger Shields and Shield Inserts: -High compressive-strength insulation, with an MSS Type 40 G90 galvanized sheet metal shield. Shield shall have rounded corners.
1. Insulation Material for Cold Piping: ASTM C 552, Type I cellular glass, or ASTM C 1126, Type III rigid phenolic foam with a minimum 3.75 PCF density.-- Insulation shall have a low perm (0.02 perm or less) all service jacket.
  2. Insulation Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.
  3. Plenum Rating: Insulation shall have a flame spread index of less than 25, and a smoke developed index less than 50, when tested in accordance with ASTM E84-15a.
  4. Insulation Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
  5. Insulation Thickness: Same thickness as adjoining piping insulation. Insulation shall span 360 degrees.
  6. Shield for Trapeze or Clamped System: Shield shall cover entire circumference of pipe (360 degrees).
  7. Shield for Clevis Hanger: Shield shall cover no less than the lower 180 degrees of pipe.
  8. Minimum Shield Lengths and Gauge:
    - a. Piping Sizes up to 3": 6" long and 20 gauge.
    - b. Additional thickness and length shall be provided as required to prevent more than 5% compression of insulation with the piping system filled.

## **2.3 MISCELLANEOUS MATERIALS**

- A. Drill-In Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used. Fasteners shall be galvanized steel, except use stainless steel where supporting stainless steel hangers and supports. Anchors shall be of the expansion-wedge or screw-in type.
- B. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, galvanized. All structural steel members, plates, shapes, and bars exposed to weather shall be hot-dipped galvanized, no exceptions.
- C. Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, non-shrink and nonmetallic, dry, hydraulic-cement grout.
1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
  2. Properties: Non-staining, noncorrosive, and nongaseous.
  3. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 3 - EXECUTION**

### **3.1 HANGER AND SUPPORT APPLICATIONS**

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Refer to Division 23 Section "Vibration Controls for HVAC" for equipment and piping systems requiring vibration isolation hangers and supports. Vibration isolated piping and equipment shall be installed such that they do not contact building structure, walls, or other building elements or work that fixed in place.

- C. Comply with ANSI / MSS SP-58 and 127 for pipe hanger selections and applications that are not specified in piping system Specification Sections. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- D. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
- E. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- F. Plastic Piping: Use padded hangers for plastic piping and any other non-metallic piping that is subject to scratching. Space hangers according to pipe manufacturer's written instructions for the project service conditions, including maximum temperature. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points. Hangers shall be of the 'V-bottom' clevis type with galvanized steel angles. Angles shall be no less than 8" long.
- G. Use thermal-hanger shield inserts for insulated piping and tubing.
- H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Modern Pipe Supports Corp. Figure 404, Government ring pipe clamp with Figure 540 turn buckle adjuster and threaded rod hanger.
  - 2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if no insulation is specified / required.
  - 5. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  - 6. Clips (MSS Type 26): For support of insulated pipes on channel type and trapeze supports that are not subject to expansion or contraction.
  - 7. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
  - 8. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  - 9. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
  - 10. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  - 11. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  - 12. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.

- J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
  3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- K. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.
- L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install factory fabricated saddles and shields of the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): Use only on hot steel piping without vapor barrier. Weld saddle to the steel pipe. Fill interior of saddle with the specified piping insulation.
  2. Protection Shields (MSS Type 40): Use on cold piping with vapor barrier, and all copper tubing. Length and metal thickness shall be as recommended by manufacturer to prevent crushing/compressing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, -insert of high-density, 100-psi minimum compressive-strength--- pipe insulation, same thickness as adjoining insulation with vapor barrier, with -a sheet metal shield.

- M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  3. Spring Hangers for Piping 3" and Smaller:
    - a. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
    - b. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
- N. Comply with ANSI / MSS SP-58 and 127 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- O. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### **3.2 HANGER AND SUPPORT INSTALLATION - GENERAL REQUIREMENTS**

- A. Hanging piping and equipment from roof and floor decking in steel framed buildings is prohibited. All equipment shall be hung from building steel structural system (e.g. steel beams and joists).
1. Piping and equipment shall be supported directly from the building's steel beams or from miscellaneous structural steel provided by the Division 23 Contractor bearing on steel beams.
  2. Joist Connections: Loads supported by steel bar joists exceeding 100 lbs. shall be located at the joist panel points, and shall not impose an eccentric load (twisting moment). Provide supplemental steel and align direct hanger connections to the joists with the joist centerline. Connect to both of the upper chord angles of the joist wherever it is possible to do so. Whenever it is not possible for loads exceeding 100 lbs. to be located a joist panel point, provide a strut to transfer the load to a panel point on the opposite chord. All joist reinforcement / modifications shall meet with the approval of the joist manufacturer and shall follow the recommendation of the Steel Joist Institute.
  3. Do not drill or cut building structural steel.
  4. Do not weld to building structural steel without explicit pre-approval from the Architect/Engineer. Repair fireproofing after welding.
- B. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements related to installation of work on the roof.
- C. Pipe Hanger Installation: Comply with ANSI / MSS SP-58 and 127-. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- D. Trapeze Pipe Hanger (MSS Type 59) Installation: Comply with MSS SP-58 and 127-. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.



1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
  3. Threaded rods shall be minimum 3/8" size.
- E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation in Concrete Slab Construction:
1. Install drilled-in mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
  2. Anchor capacity used in design shall be based on the technical data published by the manufacturer or such other method as approved by the Architect and Structural Engineer of Record.
  3. Anchor capacity is dependent upon spacing between adjacent anchors and proximity of anchors to edge of concrete. Install anchors in accordance with the manufacturer's recommended spacing and edge clearances.
  4. Reinforcing bars in the concrete structure may conflict with specific anchor locations. Exercise care to avoid damaging existing reinforcing or embedded items. The Contractor shall review the structural drawings and shall undertake to locate the position of the reinforcing bars near the locations of the concrete anchors, by Hilti 'Ferrosan', GPR, X-rays, or other non-invasive means approved by the Architect and Structural Engineer of Record. Notify the Architect and Structural Engineer of Record if reinforcing steel or other embedded items are encountered during drilling.
  5. Install concrete inserts before placing concrete.
- H. Roof-Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof support rail.
- I. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- P. Piping connections to boilers, coils, pumps, pressure vessels, chillers, heat exchangers, air separators, basket strainers, and similar items shall be supported in such a manner that no pipe load is exerted on the vessel nozzles.
- Q. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield or shield insert with clamp sized to match OD of insert.
  - 2. Install MSS SP-58, Type 39 pipe covering protection saddles, only on hot steel piping without vapor barrier.
    - a. Thermal-hanger shield inserts shall be used.
  - 3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier and on copper tubing. Shields shall span arc of at least 180 degrees with clevis hangers and roller supports, and 360 degrees with clamps.
    - a. Thermal-hanger shield inserts shall be used.

### **3.3 EQUIPMENT SUPPORTS**

- A. Fabricate structural-steel stands to suspend equipment from structure overhead.
- B. Fabricate structural steel stands to support equipment above floor where required or indicated on the Drawings. Where an equipment stand is not indicated or required, set equipment on concrete housekeeping pads no less than 4" high.
- C. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- D. Provide lateral bracing, to prevent swaying, for equipment supports.

### **3.4 WIND RESTRAINTS**

- A. Support and brace all exterior piping and equipment against the specified wind and dead loads. Final requirements for supplemental wind bracing systems and materials shall be as determined by the herein-specified delegated design engineer.
- B. Restraints and braces shall connect to the building structural system, such as flanges of structural beams, upper truss cords of bar joists at panel points, cast in place inserts, or wedge-type concrete anchors.
- C. All connections are subject to the approval of the Structural Engineer of Record. The Contractor shall submit loads at each connection to the Structural Engineer of Record for approval.

- D. Do not utilize corrugated metal roof decking for connection of wind restraints.
- E. Installation of restraints shall not cause any change in position of the restrained item resulting in stresses or misalignment.
- F. Do not brace a system to two independent structures such as a roof and a wall.
- G. Friction clips shall not be used for anchorage attachments.
- H. Equipment Restraints:
  - 1. Comply with Section 301.15 the 2018 International Mechanical Code.
  - 2. Provide wind restraints to transmit wind loads from the equipment to the equipment curb (where applicable), and from the equipment base, equipment curb, and/or equipment anchorage points to the building structural system.
  - 3. All restraint systems shall be installed in strict accordance with the equipment manufacturer's restraint guidelines and all certified data.
  - 4. Equipment mounted on vibration isolation systems shall have a bumper restraint or snubber in each horizontal direction and vertical restraints shall be provided to resist overturning. No rigid connections between equipment and the building structure shall be made that degrade the noise and vibration-isolation system indicated. Do not install any equipment or duct that makes rigid connections with the building unless isolation is not indicated.
  - 5. Refer to various other Division 23 Sections where exterior equipment is specified to be factory designed and constructed with a wind resistance rating so that the equipment itself will not suffer damage when subjected to design wind forces.
    - a. Where such requirements are met, supplemental external reinforcement and/or restraints applied to the equipment itself to provide equipment wind resistance detailed on the Drawings (if any) may be omitted.
    - b. Where such requirements are not met, supplemental reinforcement may be field-provided / field-applied to the equipment by the installing Contractor as alternative method of compliance with the specification, however such reinforcement shall meet with the approval of the Architect / Engineer, the delegated design engineer, and the equipment manufacturer.
- I. Piping Restraints:
  - 1. Provide wind restraints to transmit wind loads from the piping to the piping supports and/or roof rail, and from the support / roof rail to the building structural system.
  - 2. Comply with MSS SP-127.
  - 3. Transverse piping restraints shall be at 40-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
  - 4. Longitudinal restraints shall be at 80-foot maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
  - 5. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24-inches of the elbow or tee, or if the combined stresses are within allowable limits at longer distances.
  - 6. Hold down clamps shall be used to attach pipe to all trapeze members or support rails before applying wind restraints.
  - 7. Branch lines shall not be used to restrain main lines.

### **3.5 METAL FABRICATIONS**

- A. Furnish and install miscellaneous iron work including, but not limited to, piping hangers, piping anchors and guides, and HVAC equipment supports. Additional structural members shall be furnished and installed to support the HVAC equipment without excessive stress or strain on the building construction. Structural beams and other structural members shall be furnished and installed under this Contract for anchors and guides where the building steel is not available or of sufficient size or weight to support or anchor pipe lines and equipment.
- B. Equipment and materials furnished and installed under this Contract which are not mounted on bases or floors shall be securely attached and supported from the main supporting structure of the building by metal hangers, clamps and/or brackets. Metal hangers, clamps and/or brackets shall be of suitable design and of sufficient strength to properly and safely support the materials and equipment involved.
- C. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.
  - 1. Where exterior structural steel members are cut, drilled or welded, or galvanizing is damaged, repair with a cold galvanizing repair compound with dry film containing not less than 93 percent zinc dust by weight, and complying with DOD-P-21035A or SSPC-Paint 20, as manufactured by ZRC Products Company, or equivalent.
- D. Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.
- E. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Welding shall be done by qualified welders certified as having fully complied with acceptable qualification tests as prescribed by a reputable testing agency using procedures approved by the American Welding Society.
  - 2. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 3. Obtain fusion without undercut or overlap.
  - 4. Remove welding flux immediately.
  - 5. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### **3.6 ADJUSTING**

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated or required slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches once the coordinated installations are complete. Any rod ends within 6'-8" of the finished floor shall be provided with rubber or vinyl screw thread caps and the piping or hanger marked with low clearance warning labels.

### **3.7 PAINTING**

- A. Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION**