ITEM 11631.1103 M - HANGERS AND SUPPORTS

DESCRIPTION
This work shall consist of all labor and material for hangers, supports, mechanical vibration and seismic control for HVAC equipment and piping support work in accordance with the Contract Drawings, specifications and/or as ordered by the Engineer.

The work includes, but is not limited to the following hangers and supports for mechanical system piping and equipment:

Steel pipe hangers and supports
Trapeze pipe hangers
Metal framing systems
Fastener systems
Equipment supports
Elastomeric isolation pads and mounts
Restrained elastomeric isolation mounts
Freestanding and restrained spring isolators
Housed spring mounts
Elastomeric hangers
Spring hangers
Spring hangers with vertical-limit stops
Thrust limits
Seismic snubbers
Restraining snubbers
Steel vibration isolation equipment bases

This project is located within Seismic Zone 2. Special provisions are required for the support and restraint of HVAC equipment, piping, ductwork, etc., in the case of a seismic event so as to comply with the pertinent sections of the International Mechanical Code.

Floor mounted equipment shall be provided with approved seismic control devices as required to prevent overturning or sliding for a minimum lateral acceleration of 0.5 "g". Seismic restraints shall be capable of keeping equipment captive under seismic loads.
Ceiling mounted equipment shall be provided with approved seismic control devices as required to maintain the equipment in a captive position for a minimum lateral acceleration of 0.5 "g".

The seismic restraint design and construction requirements for equipment, piping, etc. incorporated as part of Life Safety Systems shall be such that these systems will remain in place and be functional following a seismic event.

All Life Safety Systems whether isolated or not shall be bolted to structure to allow for a minimum lateral acceleration of 1.0 "g". Bolt points and diameter of inserts shall be submitted and verified as part of the contractors' submission for each piece of equipment and be certified by a licensed structural engineer.

**MATERIALS**

**STEEL PIPE HANGERS AND SUPPORTS DESCRIPTION:** MSS SP-58, Types 1 through 58, factory-fabricated components.

**TRAPEZE PIPE HANGERS DESCRIPTION:** MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

**THERMAL-HANGER SHIELD INSERTS DESCRIPTION:** 690-kPa- minimum, compressive-strength insulation insert encased in sheet metal shield.

**INSULATION-INSERT MATERIAL FOR COLD PIPING:** Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

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

**PIPE POSITIONING SYSTEMS DESCRIPTION:** IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

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

**STRUCTURAL STEEL:** ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

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

**ELASTOMERIC ISOLATOR PADS:** Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

**ELASTOMERIC MOUNTS:** Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
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RESTRAINED ELASTOMERIC MOUNTS: All-directional elastomeric mountings with seismic restraint.

Materials: Cast-ductile-iron housing containing two separate and opposing, molded, bridge-bearing neoprene elements that prevent central threaded sleeve and attachment bolt from contacting the casting during normal operation.

Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by American Association of State Highway & Transportation Officials (AASHTO).

SPRING ISOLATORS: Freestanding, laterally stable, open-spring isolators.

Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

Minimum Additional Travel: 50 percent of the required deflection at rated load.

Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

Baseplates: Factory drilled for bolting to structure and bonded to 6-mm-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 690 kPa.

Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

RESTRAINED SPRING ISOLATORS: Freestanding, steel, open-spring isolators with seismic restraint.

Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 6-mm-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

Minimum Additional Travel: 50 percent of the required deflection at rated load.

Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

ELASTOMERIC HANGERS: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

SPRING HANGERS: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
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Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

Minimum Additional Travel: 50 percent of the required deflection at rated load.

Lateral Stiffness: More than 80 percent of the rated vertical stiffness.

Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

RESILIENT ISOLATION WASHERS AND BUSHINGS: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

SEISMIC SNUBBERS: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5.

RESTRAINING CABLES: Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement.

ANCHOR BOLTS: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to American Society for Testing and Materials (ASTM) E 488/E 488M.

VIBRATION ISOLATION EQUIPMENT BASES: Factory-fabricated, welded, structural-steel bases and rails.

CONSTRUCTION DETAILS

SUBMITTALS

Product Data: Include load deflection curves for each vibration isolation device.

Shop Drawings: Signed and sealed by a qualified professional engineer. Include the following:

Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
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Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors. Submittals for Interlocking Snubbers: Include load deflection curves up to 1/2-inch deflection in x, y, and z planes.

QUALITY ASSURANCE

Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage preapproval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

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

EXTRA MATERIALS

Seismic Snubber Units: Furnish replacement neoprene inserts for all snubbers.

HANGER AND SUPPORT APPLICATIONS

Specific hanger and support requirements are specified in Sections specifying piping systems and equipment. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

Use padded hangers for piping that is subject to scratching.

HORIZONTAL-PIPING HANGERS AND SUPPORTS: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, DN 15 to DN 750.
Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, DN 15 to DN 600, if little or no insulation is required.

Pipe Hangers (MSS Type 5): For suspension of pipes, DN 15 to DN 100, to allow off-center closure for hanger installation before pipe erection.

Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, DN 15 to DN 200.

Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, DN 15 to DN 200.

Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, DN 10 to DN 80.

VERTICAL-PIPING CLAMPS: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, DN 20 to DN 500.

Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, DN 20 to DN 500, if longer ends are required for riser clamps.

HANGER-ROD ATTACHMENTS: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Steel Turnbuckles (MSS Type 13): For adjustment up to 150 mm for heavy loads.

Steel Clevises (MSS Type 14): For 49 to 232 deg C piping installations.

Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

Steel Weldless Eye Nuts (MSS Type 17): For 49 to 232 deg C piping installations.

BUILDING ATTACHMENTS: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.

Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
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C-Clamps (MSS Type 23): For structural shapes.

Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

SPRING HANGERS AND SUPPORTS: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 32 mm.

Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.

HANGER AND SUPPORT INSTALLATION

Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

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.

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

Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

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

Equipment Support Installation: Fabricate from welded-structural-steel shapes. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
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Install lateral bracing with pipe hangers and supports to prevent swaying.

Install building attachments within concrete slabs or attach to structural steel.

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

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.

Insulated Piping: Comply with the following:
Attach clamps and spacers to piping.

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

Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

Shield Dimensions for Pipe: Not less than the following:
DN 8 to DN 90: 305 mm long and 1.22 mm thick.

EQUIPMENT SUPPORTS

Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

Grouting: Place grout under supports for equipment and make smooth bearing surface.

Provide lateral bracing, to prevent swaying, for equipment supports.

The Contractor shall install thrust limits at centerline of thrust, symmetrical on either side of equipment, seismic snubbers on isolated equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

Restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure, steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

Install resilient bolt isolation washers on equipment anchor bolts.
METAL FABRICATIONS

Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

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:

- Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
- Obtain fusion without undercut or overlap.
- Remove welding flux immediately.
- Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

ADJUSTING

Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

- Trim excess length of continuous-thread hanger and support rods to 40 mm.

PAINTING

Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- Apply paint by brush or spray to provide minimum dry film thickness of 0.05 mm.

Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

- Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

METHOD OF MEASUREMENT. This work will be measured for payment on a lump sum basis for the work completed in accordance with the Contract Documents and as directed by the Engineer.
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BASIS OF PAYMENT.
The lump sum price bid for Hangers and Supports shall include the cost of all labor, materials, equipment, accessories, and appliances necessary to complete the work as shown on the contract drawings, and as specified in the referenced section.

Monthly payment will be made for this item in proportion to the total amount of work completed up to a limit of 50% of the lump sum price bid. The remaining 50% of the lump sum price bid shall be paid after all systems in the Hangers and Supports have been tested and accepted by the Owner, and the O&M training program is completed and accepted by the Owner.

Before the first payment estimate is issued for work under this item, the Contractor shall furnish to the Engineer a detailed estimate of quantities and prices for all materials and labor included under this item, which shall aggregate the contract lump sum price bid for this item. This estimate shall be made out in such form as required and, if requested, supported by such evidence of its correctness as the Engineer may direct. This evidence shall include certified copies of subcontracts.

The Contractor agrees that this detailed estimate shall not become effective until it has been approved by the Engineer, who shall have the right to revise the estimate as, in his/her judgment, may be required to make the various subdivisions of work conform to their value. The approved detail estimate shall be used as a basis for monthly payment for work completed under this item. The proportionate share for bond premiums for this item shall not be listed as a separate item but its cost shall be distributed pro rate throughout the estimate for this item.