0.1 WSU DESIGN REQUIREMENTS

A. All hangers, supports, anchors and all associated hardware located in areas with high levels of moisture and humidity (i.e. tunnels, aquatic facilities) must be stainless steel.

B. All dissimilar metals shall be dielectrically isolated. For permanent isolations use rubber or approved insulation. During construction, temporary dielectric insulation will be provided prior to insulating the pipe.

C. All Mechanical supports must be made of metal. Exceptions must be approved by WSU Project Manager.

D. Supports will be attached to the bottom of the B-deck where applicable.

E. Powder-Activated Anchors will not be allowed for the support of mechanical equipment or piping.

F. Piping supports in tunnels should be anchored to the walls of the tunnel and not the roof structure.

G. Support elements added between building structural components (i.e. unistrut or angle iron) must be secured to the building structure in a manner approved by the structural engineer and/or the WSU project manager.

H. Obtain a Hot Work Permit from the WSU Fire Marshall 48 hours prior to any field welding or other hot work.

I. Where possible, use racking to support multiple pipes.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes hangers and supports for mechanical system piping and equipment.

B. Related Sections include the following:
1. Division 5 Section "Metal Fabrications" for materials for attaching hangers and supports to building structure.
2. Division 13 Sections on fire-suppression piping for fire-suppression pipe hangers.
3. Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for vibration isolation and seismic restraint devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.
B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design channel support systems for piping to support multiple pipes capable of supporting 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 combined weight of supported systems, system contents, and test water.
C. Design seismic restraint hangers and supports for piping and equipment.
D. Design and obtain approval from authorities having jurisdiction for seismic restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.
B. Shop Drawings: Signed and sealed by a qualified professional engineer for multiple piping supports and trapeze hangers. Include design calculations and indicate size and characteristics of components and fabrication details.
C. Welding Certificates: Copies of certificates for welding procedures and operators.

1.6 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.
   1. Professional Engineer Qualifications: A registered professional engineer who is legally qualified to practice in jurisdiction where Project is located 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.

PART 2 – PRODUCTS
2.1 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: 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 piping and equipment that will not have field-applied finish.
   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, unless bare metal surfaces are indicated.
   2. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.
   3. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
   4. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
   5. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.2 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

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

C. Grout: ASTM C 1107, Grade B, factory-mixed and packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

   1. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
   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. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

C. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

   1. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
   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 little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow offcenter closure for hanger installation before pipe erection.

6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

7. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

9. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.

16. 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.

17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. 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.

19. 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.

20. 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.
21. **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.

D. **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 ¾ to NPS 20.
2. **Carbon- or Alloy-Steel Riser Clamps (MSS Type 42):** For support of pipe risers, NPS ¾ to NPS 20, if longer ends are required for riser clamps.

E. **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. **Swivel Turnbuckles (MSS Type 15):** For use with MSS Type 11, split pipe rings.
4. **Malleable-Iron Sockets (MSS Type 16):** For attaching hanger rods to various types of building attachments.
5. **Steel Weldless Eye Nuts (MSS Type 17):** For 120 to 450 deg F piping installations.

F. **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-joist 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.
G. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high density, 100-psi minimum compressive-strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

H. 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 Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. 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.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support 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.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.

1. Field assemble and install according to manufacturer’s written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
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 D-1.1.

D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, 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.

E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

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

G. 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.

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

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, “Building Services Piping,” is not exceeded.

J. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Use thermal-hanger shield insert with clamp sized to match OD of insert.
   b. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

4. Insert Material: Length at least as long as protective shield.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

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

C. 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. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain a Hot Work Permit from the WSU Fire Marshall 48 hours prior to any field welding or other hot work.
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.

3.5 ADJUSTING

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

3.6 PAINTING

A. Touching Up: Where cleaning and touch up painting is not specified in Division 9, 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 15060
SECTION 15085 - MOTORS

PART 1 – GENERAL

0.1 1 HP or larger motors shall be high efficiency and inverter duty.

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

B. Related Sections include the following:

1. Division 15 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.3 SUBMITTALS

A. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

B. Factory Test Reports: For specified tests.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.

   1. Terms “Listed and Labeled”: As defined in the National Electrical Code, Article 100.


PART 2 - PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

B. Motors 1/2 HP and Larger: Polyphase.

C. Motors Smaller than 1/2 HP: Single phase.

D. Frequency Rating: 60 Hz.
E. Voltage Rating: Determined by voltage of circuit to which motor is connected.

F. Service Factor shall be adjusted for elevation above 3300 ft.

G. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof, unless otherwise indicated.

2.2 POLYPHASE MOTORS

A. Description: NEMA MG 1, medium induction motor.

1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.

B. Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.

C. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Critical vibration frequencies are not within operating range of controller output.
2. Temperature Rise: Match rating for Class B insulation.
3. Insulation: Class H.
4. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors.
5. Bearings: The bearings shall be totally isolated with a non-conductive insulator between the outer race of the bearing and the motor housing to completely eliminate the effects of induced shaft current as a result of using high frequency VFD’s. The insulating material shall have sufficient strength to withstand the loads of the bearing without any deterioration. Shaft grounding systems are not an acceptable alternate to this requirement. Motor bearings shall be rated for an L-10 life in excess of 200,000 hours of continuous duty and shall be of the regreasable type with plugged drain fittings.

D. Rugged-Duty Motors: Where indicated, motors are totally enclosed with 1.25 minimum service factor, greased bearings, integral condensate drains, and capped relief vents. Windings are insulated with nonhygroscopic material. External finish is chemical-resistant paint over corrosion-resistant primer.

E. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.
2. No-load readings of current and speed at rated voltage and frequency.
3. Locked rotor current at rated frequency.
4. High-potential test.
5. Alignment.
2.3 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.
   1. Permanent-split capacitor.
   2. Split-phase start, capacitor run.
   3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

PART 3 - EXECUTION

3.1 ADJUSTING

A. Use adjustable motor mounting bases for belt-driven motors.

B. Align pulleys and install belts.

C. Tension according to manufacturer’s written instructions.

D. Torque all set screws to manufacturer’s specifications.

END OF SECTION 15085
SECTION 15122 - METERS AND GAGES

PART 1 – GENERAL

0.1 All meters and electronic gages shall be able to communicate with the current BAS System (Johnson METASYS).

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes meters and gages for mechanical systems.

1.3 SUBMITTALS

A. Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

B. Shop Drawings: Include schedule indicating manufacturer’s number, scale range, fittings, and location for each meter and gage.

C. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Thermometers shall be light-power digital type:
   b. Ernst Gage Co.
   c. Marsh Bellofram.
   d. Palmer Instruments, Inc.
   e. Trerice: H. O. Trerice Co.
   f. Weiss Instruments, Inc.
   g. Winter's Thermogauges, Inc.
   h. Or preapproved equal

2. Pressure Gages:
   a. AMETEK, Inc.; U.S. Gauge Div.
   c. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
   d. Ernst Gage Co.
   e. Marsh Bellofram.
   f. Noshok, Inc.
2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions.
3. Hot Water: 30 to 300 deg F, with 2-degree scale divisions.
4. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIGHT-POWER DIGITAL THERMOMETERS

A. Description: ASTM E 1.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, 7 inches long.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

2.4 SEPARABLE SOCKETS

A. Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

1. Material: Brass, for use in copper piping.
4. Insertion Length: To extend to one-third of diameter of pipe.
5. Cap: Threaded, with chain permanently fastened to socket.
6. Heat-Transfer Fluid: Oil or graphite.

2.5 PRESSURE GAGES
A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.

C. Connector: Brass, NPS 1/4.

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.
   1. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure.
   2. Fluids under Pressure: Two times the operating pressure.

2.6 PRESSURE-GAGE FITTINGS

A. Valves: NPS 1/4 brass or stainless-steel needle type.

B. Syphons: NPS 1/4 coil of brass tubing with threaded ends.

C. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.7 TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 1/2 fitting.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Insert: Self-sealing valve, suitable for inserting 1/8-inch OD probe from dial-type thermometer or pressure gage.

E. Core Material for Air and Water: Minus 30 to plus 275 deg F, ethylene-propylene-diene terpolymer rubber.

F. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

G. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.
   1. Pressure Gage and Thermometer Ranges: Approximately two times the system's operating conditions.

2.8 DUAL TURBENE FLOW METERS

A. Manufacturers: Subject to compliance with requirements, are limited to, the following
   1. Armstrong Pumps, Inc.
   2. Badger Meter, Inc.; Industrial Div.
   5. Gerand Engineering Co.
   6. Hyspan Precision Products, Inc.
8. McCrometer, Inc.
9. Onicon, Inc.
11. Victaulic Co. of America.
12. Or preapproved equal.

B. Description: Insertion tube flow meter suitable for measuring electrically conductive water based liquids. Provides isolated 4-20 mA and 0-10 V analog output signals that are linear with the flow rate.

C. Construction: 3/16" stainless steel.

D. Pressure Rating: 400 psi.

E. Temperature Rating: 280 deg F.

F. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.

G. Operating Instructions: Include complete instructions with each flowmeter

PART 3 - EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

A. Install gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions to ensure readability.

B. Install in the following locations:
   1. Inlet and outlet of each hydronic zone.
   2. Inlet and outlet of each hydronic boiler and chiller.
   3. Inlet and outlet of each air handling units and built-up central systems.

C. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.
   1. Install with socket extending to one-third of diameter of pipe.
   2. Fill sockets with oil or graphite and secure caps.

D. Install thermometer wells in vertical position in piping tees where test thermometers are indicated.
   1. Install with stem extending to one-third of diameter of pipe.
   2. Fill wells with oil or graphite and secure caps.

3.3 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.
B. Install dry-type pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Building water-service entrance.
3. Chilled-water and condenser-water inlets and outlets of chillers.

C. Install liquid-filled-type pressure gages at suction and discharge of each pump.

D. Install pressure-gage needle valve and snubber in piping to pressure gages.

1. Exception: Install syphon instead of snubber in piping to steam pressure gages.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
2. Connect flow-measuring-system elements to meters.
3. Connect flowmeter transmitters to meters.
4. Connect thermal-energy-flowmeter transmitters to meters.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Ground electrically operated meters.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Install electrical connections for power and devices.

E. Electrical power, wiring, and connections are specified in Division 16 Sections.

3.5 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.
SECTION 15183 - REFRIGERANT PIPING

PART 1 - GENERAL

0.1 All refrigerant piping shall be rigid with brazed joints unless preapproved by WSU Project Manager.

1.1 SUMMARY

A. Includes But Not Limited To:
   1. Furnish and install piping and specialties for refrigeration systems as described in Contract Documents.

1.2 REFERENCES

A. American Society For Testing And Materials:
   1. ASTM A 36-03a, 'Standard Specification for Carbon Structural Steel.'
   2. ASTM B 280-03, 'Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.'

1.3 SUBMITTALS

A. Shop Drawings: Show each individual equipment and piping support.

B. Quality Assurance / Control: Technician certificate for use of CFC and HCFC refrigerants.

1.4 QUALITY ASSURANCE

A. Qualifications: Refrigerant piping shall be installed by a refrigeration contractor licensed by State and by technicians certified in use of CFC and HCFC refrigerants.

PART 2 - PRODUCTS

2.1 COMPONENTS

A. Refrigerant Piping:
   1. Meet requirements of ASTM B 280, hard drawn straight lengths.

B. Refrigerant Fittings:
   1. Wrought copper with long radius elbows.
   2. Approved Manufacturers.
      a. Mueller Streamline.
      b. Nibco Inc.
      c. Grinnell.
      d. Elkhart.

C. Suction Line Traps:
   1. Manufactured standard one-piece traps.
   2. Approved Manufacturers.
a. Mueller Streamline.
b. Nibco Inc.
c. Grinnell.
d. Elkhart.
e. Or preapproved equal.

D. Connection Material:
1. Brazing Rods in accordance with ANSI / AWS A5.8:
   a. Copper to Copper Connections:
      1) Classification BCuP-5 Copper Phosphorus (15 percent silver).
   b. Copper to Brass or Copper to Steel Connections: Classification BAg-5 Silver (45 percent silver).
   c. Do not use rods containing Cadmium.
2. Flux:
   a. Type Two Acceptable Products:
      1) Stay-Silv White Brazing Flux by J W Harris.
      2) High quality silver solder flux by Handy & Harmon.
      3) Or preapproved equal.

E. Valves:
1. Expansion Valves:
   a. For pressure type distributors, externally equalized with stainless steel diaphragm, and same refrigerant in thermostatic elements as in system.
   b. Size valves to provide full rated capacity of cooling coil served. Coordinate selection with evaporator coil and condensing unit.
   c. Approved Manufacturers.
      1) Alco.
      2) Henry.
      3) Mueller.
      4) Parker.
      5) Sporlan.
      6) Or preapproved equal.
2. Manual Refrigerant Shut-Off Valves:
   a. Ball valves designed for refrigeration service and full line size.
   b. Valve shall have cap seals.
   c. Valves with hand wheels are not acceptable.
   d. Provide service valve on each liquid and suction line at compressor.
   e. If service valves come as integral part of condensing unit, additional service valves shall not be required.
   f. Approved Manufacturers.
      1) Henry.
      2) Mueller.
      3) Superior.
      4) Virginia.
      5) Or preapproved equal.

F. Filter-Drier:
1. On lines 3/4 inch outside diameter and larger, filter-drier shall be replaceable core type with Schraeder type valve.
2. On lines smaller than 3/4 inch outside diameter, filter-drier shall be sealed type using flared copper fittings.
3. Size shall be full line size.
4. Approved Manufacturers.
   a. Alco.
   b. Mueller.
   c. Parker.
d. Sporlan.
e. Virginia.
f. Or preapproved equal.

G. Sight Glass:
1. Combination moisture and liquid indicator with protection cap.
2. Sight glass shall be full line size.
3. Sight glass connections and sight glass body shall be solid copper or brass, no copper-coated steel sight glasses allowed.

H. Flexible Connectors:
1. Designed for refrigerant service with bronze seamless corrugated hose and bronze braiding.
2. Approved Products:
   a. Vibration Absorber Model VAF by Packless Industries.
   b. Vibration Absorbers by Virginia KMP Corp.
   c. Anaconda 'Vibration Eliminators' by Universal Metal Hose.
   d. Style 'BF' Spring-flex freon connectors by Vibration Mountings.
   e. Or preapproved equal.

2.2 MATERIALS

A. Refrigerant Piping Supports:
1. Base, Angles, And Uprights: Steel meeting requirements of ASTM A 36.
2. Securing Channels:
   a. At Free-Standing Pipe Support:
      1) Type Two Acceptable Products:
         a) P-1000 channels by Unistrut.
         b) HS-158-12 channels by Hilti.
         c) Or preapproved equal.
      b. At Wall Support:
         1) Type Two Acceptable Products:
            a) P-3300 channels by Unistrut.
            b) HS-1316-12 channels by Hilti.
            c) Or preapproved equal.
      c. At Suspended Support:
         1) Type Two Acceptable Products:
            a) P-1001 channels by Unistrut.
            b) MS-41 channels by Hilti.
            c) Or preapproved equal.
3. Angle Fittings:
   a. Type Two Acceptable Products:
      1) P-2626 90 degree angle by Unistrut.
      2) MW2 angle by Hilti.
      3) Or preapproved equal.
4. Pipe Clamps:
   a. Type Two Acceptable Manufacturers:
      1) Hydra-Zorb.
      2) ZSI Cush-A-Clamp.
      4) Or preapproved equal.
5. Protective Cover: 18 ga steel, hot-dipped galvanized.
2.3 MANUFACTURERS

A. Contact Information:

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refrigerant Lines:
   1. Install as high in upper mechanical areas as possible. Do not install underground or in tunnels.
   2. Slope suction lines down toward compressor one inch/10 feet. Locate traps at vertical rises and any additional low points against flow in suction lines.

B. Connections:
   1. Refrigeration system connections shall be copper-to-copper, copper-to-brass, or copper-to-steel type properly cleaned and brazed with specified rods. Use flux only where necessary. No soft solder (tin, lead, antimony) connections will be allowed in system.
   2. Braze manual refrigerant shut-off valve, sight glass, and flexible connections.
   3. Circulate dry nitrogen through tubes being brazed to eliminate formation of copper oxide during brazing operation.

C. Specialties:
   1. Install valves and specialties in accessible locations. Install refrigeration distributors and suction outlet at same end of coil.
   2. Install thermostatic bulb as close to cooling coil as possible. Do not install on vertical lines.
   3. Install equalizing line in straight section of suction line, downstream of and reasonably close to thermostatic bulb. Do not install on vertical lines.
   4. Provide flexible connectors in each liquid line and suction line at both condensing unit and evaporator. Anchor pipe near each flexible connector.

D. Refrigerant Supports:
   1. Support Spacing:
      a. Piping 1-1/4 inch and Larger: 8 feet on center maximum.
b. Piping 1-1/8 inch and Smaller: 6 feet on center maximum.
c. Support each elbow.
2. Isolate pipe from supports and clamps with Hydrozorb or Cush-A-Clamp systems.
3. Run protective cover continuous from condensing units to risers or penetrations at building wall.

3.2 FIELD QUALITY CONTROL

A. Make evacuation and leak tests in presence of a WSU Representative after completing refrigeration piping systems. Positive pressure test will not suffice for procedure outlined below.
   1. Draw vacuum on each entire system with two stage vacuum pump. Draw vacuum to 300 microns using micron vacuum gauge capable of reading from atmosphere to 10 microns. Do not use cooling compressor to evacuate system nor operate it while system is under high vacuum.
   2. Break vacuum with nitrogen and re-establish vacuum test. Vacuum shall hold for 30 minutes at 300 microns without vacuum pump running.
   3. Conduct tests at 70 deg F ambient temperature minimum.
   4. Do not run systems until above tests have been made and systems started up as specified. Inform Owner's Representative of status of systems at time of final inspection and schedule start-up and testing if prevented by outdoor conditions before this time.
   5. After testing, fully charge system with refrigerant and conduct test with leak detector.
   6. Recover all refrigerant in accordance with applicable codes. Do not allow any refrigerant to escape to atmosphere.

B. If it is observed that refrigerant lines are being or have been brazed without proper circulation of nitrogen through lines, all refrigerant lines installed up to that point in time shall be removed and replaced at no additional cost to Owner.

END OF SECTION