




DATE: December 1, 2009

FROM: Ian M. Salada 

TO: Telecommunications & Software Support

RE: Design and Construction Standards Update

DIVISION(S): 23

SECTION(S): 23 05 19

REC'D DEC 02 2009

Completed

DEC 03 2009

Minor change to correct format problem or typographical errors
No entry in the revision log required

Revision Log Entry Required

Description of Change: Revise thermometer and gauge requirements in HVAC systems.

Copy of changes sent via email also
clh291
cal9

Delete the following current text in its entirety (deletions are shown struck through). Renumber paragraphs that follow deleted text.

23 05 01 Mechanical General Requirements

~~.02 Pressure Gauges and Thermometers~~

- ~~A. Gauges for general use shall be "Quality" type as manufactured by Marsh Instrument Company or equal. Gauges shall have a 4 1/2 inch diameter dial. In main mechanical room, HVAC Contractor shall provide 6" diameter gauges for all steam pressures and pumped condensate pressure. The Plumbing Contractor shall provide similar gauges for water and air. Gauges shall be calibrated for static head. All gauges shall be equipped with shutoff valves and snubbers.~~
- ~~B. Siphons shall be used with all steam gauges. Also, all gauges shall have gauge cocks or valves suitable for the pressure involved.~~
- ~~C. Thermometers for general use shall be stem type with an adjustable bracket. Thermometers shall be organic liquid filled (red) in lieu of mercury filled.~~
- ~~D. The scale on gauges and thermometers shall be read to twice the operating pressure or temperature. The Professional shall specify gauge and thermometer ranges.~~

Insert following text.

23 05 19 – MEASURING INSTRUMENTS FOR HVAC

.01 General

- A. Provide all measuring instruments as required to achieve proper balancing, calibration of electronic sensors, and routine inspection, maintenance and troubleshooting of mechanical systems.
 - 1. Provide permanent gauges and thermometers on all central equipment and temperature / pressure control zones in all mechanical and utility rooms.
 - 2. Provide pressure and temperature test plugs adjacent to all electronic pressure or temperature BAS sensors in hydronic systems (for testing/calibration purposes), on all terminal heating and cooling equipment, and at temperature/pressure control zones in hydronic systems in non-occupied spaces, such as above ceilings or below raised floors.
 - 3. Provide permanent venturi flowmeters on pumps; and on primary / dedicated hydronic flow control zones where flow/gpm point is scheduled on control sequences. (Review specific applications with OPP Engineering Staff).
 - 4. Refer to Division 33 - Utilities for Utility meters (campus chilled water, steam, gas).
- B. Provide instruments with scale ranges selected according to service.
- C. Quality Assurance: Comply with applicable portions of ANSI, ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

D. Submittals:

1. **Product Data:** Submit manufacturer's technical product data for each type of measuring instrument. Submit schedule showing manufacturer's model number, scale range, location, and accessories for each type and application.
2. **Submit maintenance data and spare parts lists for each type of measuring instrument. Include this data and product data in Maintenance Manual.**

E. RELATED DOCUMENTS

1. 23 21 13 Hydronic Piping
2. 23 21 23 HVAC Pumps
3. 25 00 00 INTEGRATED AUTOMATION
4. 33 60 00 HYDRONIC AND STEAM ENERGY UTILITIES
5. 33 63 00 STEAM ENERGY DISTRIBUTION

.02 Products

A. PRESSURE GAUGES

1. **General:** Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
2. **Type:** General HVAC grade, 1% accuracy, ANSI B40.1 grade A, glycerine filled phosphor bronze bourdon type, rotary brass movement with front recalibration adjustment bottom connection.
3. **Case:** Aluminum or nylon, glass (or acrylic) lens, 4½" diameter typical
4. **Connector:** Brass with ¼" male NPT. Provide protective syphon when used for steam service.
5. **Scale:** White coated aluminum, with permanently etched black markings.
6. **Set Hands:** Where pressure gauges are indicated for use across pump suction diffusers or straining / filter devices, provide adjustable set hands to indicate recommended pressure ranges of system.
7. **Range:** Select for normal operating pressure to be approximately mid range of scale with full scale range shall be selected to be approximately 1.5 to 2.5 times the normal maximum operating pressure. The following typical ranges are suggested. The Professional shall select/specify final per specific system requirements:
 - a. **Vacuum:** 30" Hg - 30 psig (Compound)
 - b. **Water:**
 - 0 - 15 psig (between 2 to 10 psig max operating pressure)
 - 0 - 30 psig (between 10 to 20 psig max operating pressure)
 - 0 - 60 psig (between 20 to 40 psig max operating pressure)
 - 0 - 100 psig (between 40 to 60 psig max operating pressure)
 - 0 - 160 psig (between 60 to 100 psig max operating pressure)
 - 0 - 200 psig (between 100 to 130 psig max operating pressure)
 - 0 - 300 psig (between 130 to 200 psig max operating pressure)
 - c. **Steam:** 0 - 200 psig (High Pressure – up to 125 psig max operating)

- 0 - 100 psig (Medium Pressure – up to 50 psig max operating)
- 0 - 30 psig (Low Pressure – up to 15 psig max operating)

8. GAUGE ATTACHMENTS

- a. Snubbers: ASME B40.100, brass; with ¼" NPT, ASME B1.20.1 pipe threads and porous-stainless steel filter-type surge-dampening device. Include extension for use on Insulated piping.
- b. Siphons: Loop-shaped section of brass (for normal operating pressure/temperature up to 200 psi, 325 ° F) or stainless-steel (for normal operating pressure/temperature greater than for brass) pipe with ¼" NPT pipe threads.
- c. Valves: Brass body, stainless ball, selected for working pressure suitable for application, with ¼" NPT, ASME B1.20.1 pipe threads.

9. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- a. Ashcroft Inc.
- b. Ernst Flow Industries
- c. Marsh Instruments
- d. Miljoco Corporation
- e. Trelice, H.O. Co.
- f. Weiss Instruments Inc.
- g. Weksler

B. LIQUID-IN-GLASS THERMOMETERS

- 1. General: Provide stem type glass thermometers, per Standard ASME B40.200, of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
- 2. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9" long, acrylic or glass window face.
- 3. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
- 4. Tube and Capillary: Glass with magnifying lens, blue or red organic liquid (non-mercury), 1% scale range accuracy, shock mounted.
- 5. Scale: Satin faced, non-reflective aluminum, permanently etched markings.
- 6. Stem: Copper-plated steel, aluminum, or brass, for separable socket, length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - b. Design for Air-Duct Installation: With ventilated shroud.
- 7. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

8. Range: Full scale range shall be selected to be approximately 1.33 to 2.0 times the normal maximum operating temperature. The following typical ranges are suggested. The Professional shall select/specify final per specific system requirements:
 - a. Chilled Water (40-75 ° F max): 0 - 100° F with 1° F scale divisions.
 - b. Condenser-Water Piping: 0 to 160° F with 2° F scale divisions.
 - c. Hot Water (120-180 ° F max): 30 - 240° F with 2° F scale divisions.
 - d. Steam and Steam-Condensate Piping: 50 to 400° F with 5° F scale divisions.
 - e. Conditioned Air Ducts: 0 to 160° F with 2° F scale divisions.

9. Thermowells:
 - a. Standard: ASME B40.200.
 - b. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
 - c. Material for Use with Copper Tubing: Brass
 - d. Material for Use with Steel Piping: Brass or Stainless Steel.
 - e. Bore: Diameter required to match thermometer bulb or stem.
 - f. Insertion Length: Length required to match thermometer bulb or stem.
 - g. Lagging Extension: Include on thermowells for insulated piping and tubing.
 - h. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
 - i. Heat-transfer compound: Shall be used to improve thermal transfer and to eliminate condensation forming within the thermowell. Compound shall consist of synthetic, efficient thermally conductive ceramic or metal oxides in a homogeneous, non-hardening paste with negligible bleed and evaporation loss. Compound shall not cause catalytic corrosion between probe material and thermowell).

10. DUCT-THERMOMETER MOUNTING BRACKETS Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

11. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. [Ashcroft Inc.](#)
 - b. [Ernst Flow Industries](#)
 - c. [Marsh Instruments](#)
 - d. [Miljoco Corporation](#)
 - e. [Terice, H.O. Co.](#)
 - f. [Weiss Instruments Inc.](#)
 - g. [Weksler](#)

C. PRESSURE/TEMPERATURE TEST PLUGS

1. Construct of brass, equip with NPT fitting, with self-sealing, dual valve core type Nordel gasketed orifice suitable for inserting 1/8" O.D. probe assembly from dial type insertion thermometer or pressure gauge. Test plugs shall be pressure rated for 500 psi and 275°F. Equip orifice with gasketed screw cap and chain. Provide extension of length equal to insulation thickness for insulated piping.
2. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering pressure/temperature test plugs which may be incorporated in the work include; but are not limited to, the following:
 - a. Peterson Equipment Co.
 - b. Sisco

c. Watts Regulator

D. Venturi Flowmeters:

1. Description: flowmeter assembly shall be commercial HVAC grade, venturi type, calibrated flow-measuring element including, hoses or tubing, fittings, valves, indicator, and conversion chart. All Venturi meters shall be manufactured under an ISO 9001:2000 certified quality program.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: low pressure loss venturi-type, calibrated, flow-measuring element; for installation in piping.
 - a. Design: Differential-pressure-type measurement for suitable for HVAC hydronic fluids, gases and steam.
 - i. The Venturi inlet section shall be cylindrical with a pressure sensing tap and of the same diameter as the incoming pipe section and followed by a precise smooth contoured radius section causing a uniform change in fluid velocity, and to maintain a low permanent low pressure loss.
 - ii. Accuracy: shall be within ± 2.0 uncalibrated ($\pm 0.5\%$ calibrated) with a repeatability of $\pm 0.1\%$ and turndown of 10:1
 - b. Construction: Bronze, brass, or factory-primed steel, or as otherwise required to meet the intended service conditions if atypical, with extensions on sensing taps allowing for pipe insulation thickness and brass ball valve connections suitable for connection of tubing to flow indicating assembly.
 - c. Provide permanent, stainless steel tag with pipe size, manufacturer's nameplate and flow conversion data on chain as required so that tag remains visible and not covered by insulation.
 - d. Minimum Pressure Rating: 250 psig or not less than 1.5 times maximum system working pressure, whichever is greater.
 - e. Minimum Temperature Rating: 250 deg F.
 - f. End Connections for 2" and Smaller: Threaded.
 - g. End Connections for 2-1/2" and Larger: Flanged or grooved.
 - h. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.
4. Flow indicating assembly: Shall consist of:
 - a. Three valve manifold
 - b. local direct reading gauge suitable for wall or bracket mounting, calibrated for connected flowmeter element, 4" min. diameter dial with threaded fittings
 - i. Scale: Gallons per minute (**verify and coordinate any special requirements to adjust for use with glycol solutions**).
 - ii. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.
 - c. DP/Flow Transmitter (Where applicable - coordinate requirements with 25 00 00 INTEGRATED AUTOMATION)
 - i. When applicable, a DP transmitter with calibrated local electronic display of gpm may be used in lieu of direct read dial gauge.
 - d. Additional P/T ports at each tap for local independent verification without disassembling tubing.
 - e. copper tubing for connecting components together and to flowmeter taps.
5. Operation and Maintenance Data:
 - a. Conversion Chart: Flow rate data compatible with sensor. Include all data for each meter clearly recorded in Manual.
 - b. Operating Instructions: Include complete instructions with each flowmeter.

6. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. ABB; Instrumentation and Analytical.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Preso Meters; a division of Racine Federated Inc.
 - e. S. A. Armstrong Limited; Armstrong Pumps Inc.
 - f. Victaulic Company.

.03 Execution

- A. General:
 1. Install gauges and thermometers in locations where they are easily read from normal operating level.
 2. Coil and conceal excess capillary on remote element instruments.
- B. Pressure Gauges: Install pressure gauges with snubber in piping tee with pressure gauge valve(s), located on pipe at most readable position. Install siphon for steam pressure gauges. Extend nipples and siphons to allow clearance from insulation. Install pressure gauges in the following locations:
 1. Inlet and Discharge of each pressure-reducing valve. One gauge on common inlet may be used for pressure reducing stations with multiple reducing valves.
 2. Single gauge with isolation valves across inlet and outlet of each of the following:
 - a. chiller chilled-water and condenser-water connection.
 - b. Hydronic heat exchangers.
 - c. Hydronic pumps.
 - d. Major strainers and filter housings (include adjustable set hands to indicate upper limit when service is required).
 - e. Exception: Individual gauges are permitted if length of tubing would be excessive or impractical for the preferred single gauge method.
 3. Connection to expansion tank
 4. Single gauge with isolation valve manifold across supply and return at each piping system remote differential pressure sensor/transmitter (used to control VFD).
- C. Thermometers: Install thermometers in the following locations:
 1. Inlet and outlet of each hydronic boiler.
 2. Inlets and outlets of each chiller (chilled water and condenser water supply and return).
 3. Two inlets and two outlets of each hydronic heat exchanger.
 4. Inlet and outlet of each hydronic zone (each secondary or tertiary loop with independent temperature control)
 5. Inlet and outlet of each hydronic coil in air-handling units.
 6. Inlet and outlet of each thermal-storage tank.
 7. Each inlet and outlet of air to air heat recovery device.
 8. Outside-, return-, supply-, and mixed-air ducts.
 - a. Install thermometers in air duct systems on flanges.
 - b. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices.
- D. Thermometer Wells: Install thermometers in piping systems in wells in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer wells. Ensure wells allow clearance from insulation. Fill voids between thermowell and thermometer and BAS sensor stems with heat conducting compound before installing in wells.

- E. Install pressure/temperature test plugs in piping tee, located on pipe at most accessible and readable position. Secure cap. Install where required to allow for balancing and troubleshooting without requiring permanent pressure gages and thermometers, including but not necessarily limited to the following locations:
1. Adjacent to all pressure or temperature BAS sensors in hydronic systems (for testing/calibration purposes).
 2. At inlet and outlet of each hydronic terminal heat transfer device, such as:
 - a. air handling coils
 - b. terminal heating and/or cooling units
 - c. temperature control zones
 - d. At each location where major return streams mix (for troubleshooting)
 - i. In common pipe, approximately 10 pipe diameters downstream of mixing point.
 - ii. In each upstream pipe section
 3. At inlet and outlet of each variable pressure change device, such as:
 - a. Strainers at minor/zone pumps and central air handling equipment coils. Not required at strainers of small terminal heating/cooling units.
 - b. Manual and automatic calibrated balancing valves (specify as manufacturer's options factory fabricated on valves).
- F. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate.
1. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
 - a. For gauges on straining/filtering devices, adjust set hands on pressure gauges to accurately indicate when service is required (approximately 50% above pressure differential when clean (or as otherwise recommended by strainer/filter manufacturer).
 - b. After installation, zero and/or calibrate meters and gauges according to manufacturer's written instructions.
 2. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.
- G. Venturi Flow Meters:
1. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
 - a. Example: <http://www.preso.com/resources/tech/VenturiInstructions8.5-11.pdf>
 2. Install flowmeter elements in accessible positions in piping systems.
 3. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
 4. Install permanent indicators on walls or brackets in accessible and readable positions.
 5. Install connection fittings in accessible locations for attachment to portable indicators.

END of revisions

Update Commentary:

Section was added primarily for the following reasons:

- 1) To add requirements for pressure/temperature ports
- 2) To add General Owner Requirements in order to define basic design intent, selection criteria, quality assurance, submittals, and coordination for measuring instruments.
- 3) To update the Product Requirements for the technical specification details of measuring instruments.

4) To add Execution requirements to define typical installation requirements.