The Ohio State University
High Pressure Steam System
Hot Water Converter and Steam Meter

This document shall serve as a design guideline for building heating water converter and metering systems supplied by high-pressure steam in main campus buildings.

Fundamental operation shall be the generation of heating hot water using Campus Power Plant High Pressure Steam (HPS) at 185 psig superheated to 580°F directly into a shell and tube heat exchanger. Steam to Hot Water Converters shall be sized and rated for 125% of system operating capacity. This will accomplish sub-cooling of condensate below corresponding saturated steam pressure. Condensate system shall be of the closed loop, un-vented, pump-trap combination type. All system components shall be rated for use under the above stated operating conditions. Steam control valve(s) shall be industrial grade, rotary eccentric plug type. Condensate mover shall be a high-pressure steam powered pump. Trap for heating load shall be float and thermostatic type. Traps for drips shall be thermodynamic. A pilot operated back-pressure regulating valve (BPR) shall be incorporated into the steam condensate system to vent flash steam when pressure exceeds 25 psig. Building heating plants shall consist of a minimum of two (2) complete converter systems including controls and isolation valves to allow operation of any combination of pump(s) and converter(s). Examples of converter system sizing are: 67% (2/3) of total building heating requirement supplied by each of two (2) converter systems, 50% (½) of total building heating requirement supplied by each of three (3) converter systems.

Various other steam loads such as domestic hot water, humidification, laboratory, and other process loads shall be generated through the use of similar steam to hot water heat exchangers or steam to steam reboilers.

Refer to other sections of the OSU Building Design Standards (BDS) for piping materials and methods.

System Description: (Refer to piping schematic)

HPS shall extend to vicinity of converter. Double block and bleed valves shall be installed to isolate each converter independent of other equipment or devices. Steam flow to each converter shall be controlled through the use of two (2) control valves in parallel, sized for 25% (¼) and 75% (¾) of the system requirement. The ¼ valve shall be modulated to control converter leaving water temperature. The ¾ valve shall be incremented open or closed in steps based on position of the ¼ valve. A temperature sensor shall be installed in the condensate line ahead of the mover. This sensor shall be used in the control scheme to limit condensate temperature by resetting steam control valve position under start-up conditions. A self-contained pilot operated steam control valve shall be installed in a by-pass line to provide minimum heat in the event of a control system failure. Anticipated sizing of this by-pass line and valve shall be for 25% of total system capacity. It shall have a field adjustable set point with a range of 130° F to 170° F.

With the exception of steam control valves and converter shell connections (which shall be flanged), all HPS piping, equipment, and device connections shall be welded.

Closed loop pump/trap combination condensate return systems require a dedicated mover for each converter. Condensate shall flow by gravity into a receiver vessel sized to adequately store volume of condensate generated under design conditions during the pump-out cycle of the mover. The vent line of the mover shall be connected to the top of this receiver. Minimum fill head between bottom of converter shell and top of receiver, and bottom of receiver and top of mover, shall each be eighteen

inches (18”). The BPR Valve shall be connected independently to condensate receiver. BPR valve discharge piping shall extend safely to the outdoors.

Butterfly Valves (steam):

PERFORMANCE:

I. Rotary valves shall have performance characteristics as listed below.

A. Service: steam

B. Working pressure, max., psig: 300

C. Working Temperature, max., 650 deg. F.

II. Valve shall be rated at full working pressure per API 607 hardseat 4th edition. Each constructed valve shall be tested for zero leakage under water at working pressure using air and for watertight operation.

CONSTRUCTION:

I. Metal seated rotary tight shutoff valve shall be quarter–turn, triple offset type construction with buttweld ends as detailed below.

Service: steam

1. Installation: Above ground or steam vaults.
2. Size, in.: As shown on drawing.
3. Body type: Butt weld rotary valve
   a) Body material WCB carbon steel.
4. Seat: Stellite or similar hard surfaced material
   a) Resilient, non-flexing laminate metal seal composite of stainless steel and graphite retained such that centering movement is permitted.
   b) Retainer screws and plate will be of stainless steel, nickel or other non-corrosive materials.
   c) Disk shall be stainless steel or nickel plated carbon steel.
5. Shaft shall be of single piece construction.
6. Disk movement relative to shaft rotation shall be triple offset design.
7. Per ANSI B16.5, 31, 34 construction for body components B31.1, 31.3, ASME sections VIII, IX.
8. Valves to meet API 607 Rev. 4 standards.
9. Hardened bearings with bearing seal to be retained in body.
10. Shaft seal shall be graphite with multiple stud packing gland follower for adjustability utilizing Belleville style washers.
11. Right angle gear with 2 in. AWWA nut, with loose steel hand wheel or chain wheel attachment, for remote “tee” handle operation, as shown on drawings

II. Rotary valves for service requiring insulation shall be equipped with stem and stem housing of suitable length to clear insulation.

III. INSTALLATION:

a. Install rotary valves where indicated on the drawings.

APPROVED MANUFACTURERS:

I. Adams (300 ANSI carbon steel type MAK)

II. Vanessa 30,000 series

III. Fisher

Steam Control Valve(s):

Valve Body/Trim -

1. Rotary Eccentric-Plug style control valve
2. WCC carbon steel body material.
3. ANSI 300RF flanged per ASME/ANSI B16.5-1988.
4. Flow characteristics: linear
5. Class IV shutoff classification as defined by ANSI/FCI 70-2-1991.
6. Graphite stem packing.
7. Trim materials to consist of Chromium-plated CF8M (316 SST) Ball, 316 SST/CoCr-A metal seat ring, 440C SST bearings, 316 SST shaft.
8. Powder coat paint on body exterior.

Actuator -

1. Spring and diaphragm style.
2. Fail closed valve action.
3. Molded diaphragm to provide linearity between loading pressure and travel.
4. Actuator size to be determined by vendor.
5. Elastomers to be nitrile for ambient temperatures between -40 to 180 deg. F. and viton for ambient temperatures between 180 and 300 deg. F.
6. Travel scale for full rated valve travel.
7. Spring adjuster for spring tension adjustment.

I/P Positioner -

1. Pneumatic two-stage style with internal zero and span adjustments
2. Independent linearity - +/- 1.0% of output signal span.
3. Hysteresis - 0.5% of span.
4. Cam characteristic - linear.
5. Deadband - 0.3% of input span.
6. Steady state air consumption less than 30 scfh.
7. Output signal to match vendor-determined actuator input signal.

8. Input signal 4-20 ma.
9. Include output and supply gauges.
10. Include supply regulator factory preset to 5 psig above maximum output signal.
11. Positioner and regulator to be factory mounted with standard copper tubing.

APPROVED MANUFACTURERS:

I. Neles-Jamesbury

II. Fisher

Steam to Hot Water Converter(s):

Steam to Hot Water Converter(s) shall be shell and tube design with steam in the shell and water in the tubes. Converter tubes and tube sheets shall be type 316 Stainless Steel. Shell shall be provided with 300 # flange connections. Shell side shall be rated for 200 psig steam pressure and temperature of 600
degrees F. Tube side shall be rated for 150 psig and temperature of 600 degrees F. Converters shall be sized and rated for 125% of system operating capacity.

Pressure Powered Condensate Mover

1. Non-Electric Condensate recovery pumps.

   1.1 Provide packaged condensate return unit including support frame. All appropriately sized check valves, shut-off valves, steam valve(s), cycle counter, and gauge glasses shall be pre-installed and ready for operation.

   1.2 The unit shall be factory tested as a complete assembly and shall be shipped as a complete assembly.

   1.3 Acceptable manufacturers:

   - Watson-McDaniel
   - Spirax-Sarco
   - Spence.

2. Product

   2.1 Non-electric condensate pump shall be pressure-powered type sized to meet the actual maximum capacity of the system being drained. Operation shall be controlled by a float operated, snap action mechanism with no external seals or packing, utilizing check valves for flow direction. They shall be of non-cavitating design operating with up to 200 psig at 600°F motive steam, and be capable of handling water at 350°F when pumping from a closed loop, equalized system. All pumps shall incorporate lift or wafer type check valves unless otherwise noted and pumps shall be supplied with a factory fitted, removable insulation cover.

   2.2 The pump shall incorporate either a flash receiver, receiver pipe or a factory assembled tank package to allow for flash steam venting in an atmospheric system. Where a package system is used, all interconnecting condensate inlet piping, isolation valves, base, pump(s), and tank shall be completely assembled and ready for operation. The tank package system shall be capable of building entry through a standard 36” doorway.

2.3 Closed loop, pressure powered pump/trap combination shall be provided as required on equipment with modulating steam supply and elevated or otherwise pressurized condensate return lines. When the load changes, backpressure due to either elevation, flash or deaerator pressure will at times be above exchanger and trap inlet pressure. A positive pressure differential across the trap must be maintained through an equalized closed loop steam system using steam as the motive pressure. The system drainage assembly shall include reservoir pipe, pump check valves, liquid level sight glass ,and float/thermostatic trap. Trap sizing shall be by manufacturers' recommendation. Conventional method for trap sizing is based on standard pressure drop with a capacity multiplier of five (5).

2.4 Pump Body shall be made of cast steel and all mechanism linkage parts shall be made of stainless steel for improved longevity. The check valves shall be stainless steel. A guarded gauge glass shall be included for all applications. All components up to and including the trap shall be rated for operation at 200 psig steam and 600 degrees F.

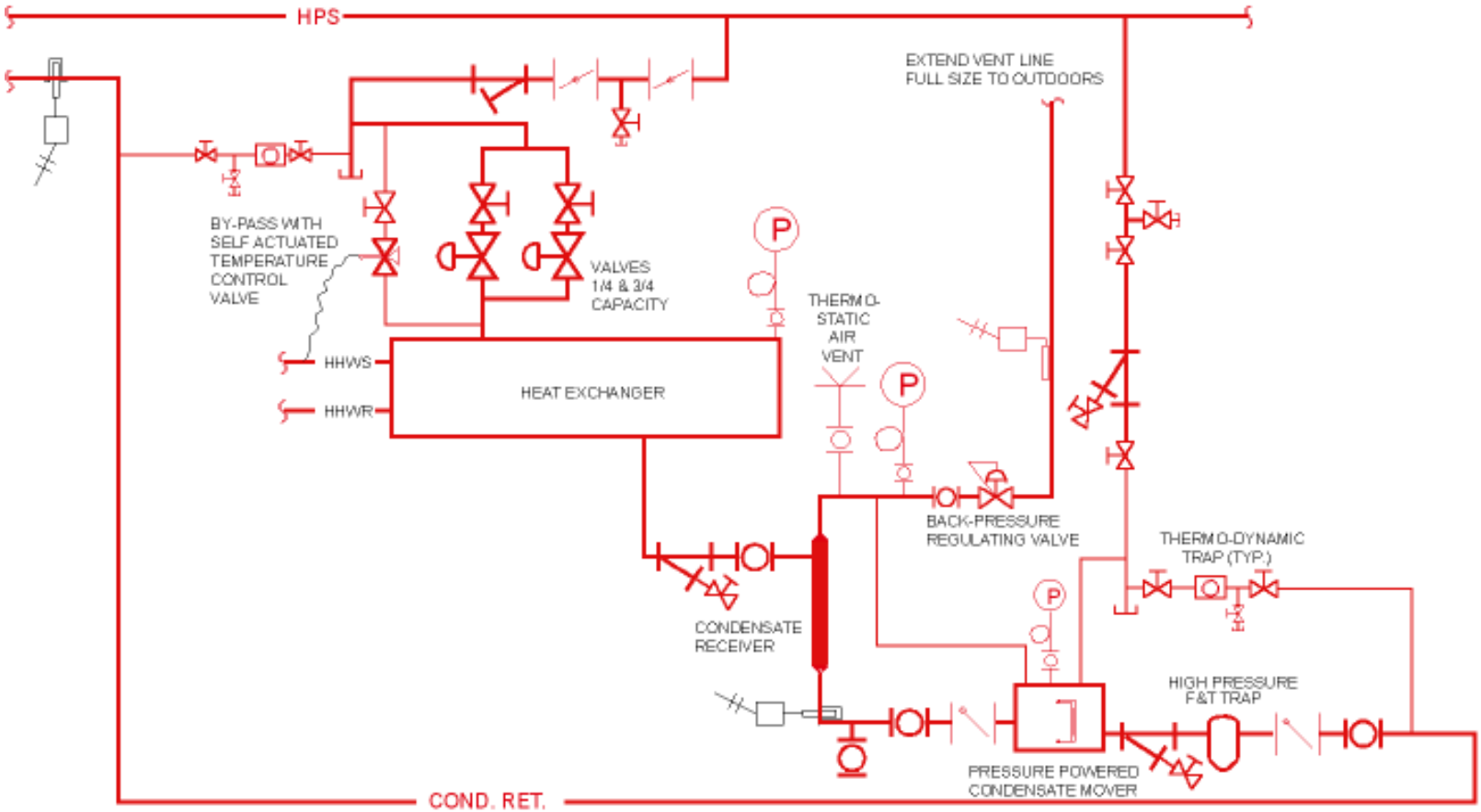
High Pressure Steam Flange Connections:

Flange Gaskets:

All flange gaskets used on 200 psig 600 degree F steam components and piping shall be rated for 300 psig 600 degree service. Gasket type shall be concentric corrugated hollow metal core encapsulated with flexible graphite, As manufactured by M&P, Graphonic. Paper or fiber gaskets, though rated 300 psig, are not acceptable.

Flange Bolts:

All 200 psig 600 degree steam flange bolts shall be "Grade 8, NC (national course) and shall be installed with a "Anti Seeze" coating on thread surfaces. Bolts shall be tightened following manufacturer's torque and sequence recommendation.



HIGH PRESSURE STEAM CONVERTER PIPING SCHEMATIC

NO SCALE

Steam Meter:

1. General

1.1 Scope

A. The main objective of this design standard is to outline the requirements of a steam meter, to measure the consumption of steam supply in total pounds (lbs) in the buildings owned by the Ohio State University, and to communicate this consumption locally and to the campus-wide Energy Metering & Monitoring system. The steam meter shall include the instantaneous mass flow rate in pounds per hour (lbs/hr) and totalized mass consumption in pounds (lbs), with steam pressure and steam temperature compensation.

B. The steam meter, elements and devices shall be custody transfer measurement. Custody transfer measurement furnishes quantity and quality information which can be used as the basis for a change in ownership and/or a change in responsibility for materials, e.g., billing for rate of energy demand plus totalized energy transfer.

C. Paragraph 3. Products, describes the general requirements for the totalizing steam meter, primary element, a multivariable transmitter, secondary element, and an RTD temperature sensor/transmitter.

1.2 Submittals

A. Data sheets, catalog literature, installation instructions, and Operations & Maintenance data must be sent to the Ohio State University Utilities Division for prior review and approval, to include the primary element flow sensor, secondary element(s) (transmitters, multivariable transmitter, etc.), RTD temperature sensor/transmitter, and flow computer.

B. Interconnections and drawings for installation of the primary, secondary, and tertiary elements of the corresponding devices shall be submitted prior their installation for review and approval.

C. Certificates for the calculation and conformance of the steam meter according to engineering procedures and practices, and standards, shall be provided. Temperature and pressure compensation, coefficients, linear regressions, constants, equations, methodologies and basis of calculations to establish the steam flow rates shall also be provided for review.

D. Certificates of calibration for the steam meter with air or any other gas available in the calibration facility, as well as a certificate of calibration conformance for the transmitters in accordance to NIST, U.S. National Institute of Science and Technology.

2. Premises for the Selection of the Steam Meter

2.1 The selection of the steam meter shall be based on the following parameters and recommendations to guarantee that the accuracy of the steam meter station stays within the ± 1% of the actual reading from 5% to 100% of the maximum rated flow, and the repeatability within ± 0.5%.

A. The supply pressure could vary between 120 and 200 psig, whereas the temperature changes between 400 and 660°F.

B. The pipe diameter shall be known and shall never be reduced to install the steam meter.

C. The location of the steam meter shall comply with the straight-run pipes upstream and down stream recommended by the manufacturer.

D. The mass flow rate shall be computed in lbs/hour, temperature and pressure compensated. The steam meter turndown shall be no less than 30 to 1 based on actual flow conditions.

E. The pressure drop through the primary element, sensor, shall not be greater than 200 inches w.g.c. for the maximum mass flow rate.

F. The multivariable transmitter shall provide a 4-20 mA signal for the temperature and pressure compensated mass flow rate in lbs/hour. The flow computer shall totalize the mass flow rate and shall be equipped with a Modbus TCP/IP communications port or other approved remote communications capability. Prior to flow computer approval, the flow computer must be submitted by the Contractor for testing by the Ohio State University Utilities Division to prove interoperability with Utilities Department campus-wide Energy Metering & Monitoring system (Power Management Ion Enterprise).

G. A remote readout located 5 feet above floor level shall be provided for those cases where the display of the steam meter is more than 6 feet or less than 4 feet above the floor level.

3. Products

3.1 Primary Element, Flow Sensor

A. A Variable Area either non-spring loaded or spring loaded, or an Ultrasonic type sensor shall be used as the primary element of the steam meter. The material of the components of the flow sensor must be 316-stainless-steel or approved material. The nominal size of the sensor shall match the size of the pipe where the flow sensor will be installed. The primary element shall comply with standard codes, ISO, ASME.

B. For those cases that apply, the flow sensor shall be installed in a wafer or lug type arrangement, constructed of 316 stainless steel, or approved material, rated for 200 psig and 660°F. If the primary flow element is longer than it's flange-to-flange dimension, then a spool piece shall be included of sufficient length such as to permit the removal of the primary flow element with spool piece, and eliminate disassembly of any downstream or upstream piping when servicing the element.

C. Calculations, equations and/or methodology used to determine the size of the flow sensor shall be supplied to the Ohio State University Utilities Division for acceptance. Where applicable, Reynolds number dependent equations shall be checked for maximum and minimum mass flow rates.

D. Upstream and downstream distances shall be in conformance with the recommendations of the manufacturer, and shall be verified to fulfill the ASME MFC-3M 1989 Ed. or AGA-3 requirements.

3.2 Secondary Element, Transmitter(s), Multivariable Transmitter

A. The output shall be 4-20mA with digital signal preferable with HART protocol. The accuracy shall be at least ±0.1% of span, 4 to 20mA, and ±0.07% of span, digital. Drift less than ±0.1% of URL over at least 8,000 hours.

B. Range limits for the differential pressure measurement shall be 0 to 200 inches of H_2O with a minimum transmitter pressure rating of 300 psi. Range limits for absolute pressure shall be 0 to 300 psia. The transmitter shall be energized with a 24-VDC source or a 120-VAC source for flow computers.

C. Programming shall be accomplished via a Windows-based software package or from the keypad of the computer flow without the need to open the cover. Thus maintaining the NEMA 4 integrity of the enclosure.

D. Standard LCD indicator shall be included.

E. The multivariable transmitter shall provide precise and reliable measurement of absolute and differential pressure, sensor and electronics temperatures, and process temperature from an external RTD. It shall calculate densities, according to Steam Tables ASME 1997, and mass flow rates for the actual pressure and temperature in line.

F. The process connectors, NPT ¼-inch, shall be 316 stainless steel. A 316 stainless steel 3-valve manifold to mount the transmitter shall be supplied. Drain/vent material and isolation valves shall be also 316 stainless steel and furnished.

G. The multivariable transmitter shall be supplied with at least 12 feet of AWG-18 shielded twisted pair cable for the RTD input connection.

3.3 RTD Temperature Sensor/Transmitter

A. A spring loaded RTD assembly with transmitter shall be furnished.

B. The temperature process input range shall be 20 to 800°F.

C. The thermo-well shall be 316-stainless steel, long enough for the size of the process pipe, and provided with a ¾-inch NPT connection.

4. Certifications

4.1 Calibration and Calculations

A. A conformance certificate for the calibration of the steam meter shall be provided.

B. A certified calculation, for the maximum and minimum mass flow rates at 185 psig and 540°F shall be supplied.

C. Calibration of the transmitter(s) or multivariable transmitter, shall be accomplished following NIST standards. A certification of conformance shall be submitted.

5. Warranty and Operation and Maintenance Manuals

5.1 Terms

A. The supplier/manufacturer shall train the Ohio State University Utilities Division personnel to program, calibrate, operate and maintain the above-mentioned devices for at least 3 hours. Training shall be scheduled within two weeks of completion of the installation.

B. The supplier/manufacturer of the above specified equipment shall guarantee for twenty four (24) months from equipment startup or thirty (30) months from date of shipment, whichever occurs first, that the equipment shall be free from defects in design, workmanship or materials.

C. In the event a component fails to perform as specified or is proven defective in service during the warranty period, the manufacturer shall promptly repair or replace the defective part at no cost (freight, labor at manufacturer facility and parts) to the Ohio State University.

D. The manufacturer or contractor shall furnish the Ohio State University Utilities Division with an installation, operation and maintenance manual of

the steam meter and all its components. Including the flow computer and a program manual.

6. Inspection

6.1 A representative of the Ohio State University Utilities Division will inspect the installation and performance of the steam meter for acceptance and approval before commissioning.

7. Pre-approved Steam Meter Manufacturers and Models

Spirax/Sarco ILVA flow sensor with Gilflo Steam Flow Computer, including pressure transmitter, temperature sensor and transmitter, differential pressure transmitter and accessories.

McCrometer V-Cone flow sensor with mass flow transmitter and RTD.

GE Panametrics Transient Time Ultrasonic steam flow meter, including flow computer, and pressure and temperature transmitters for flow compensation.

Other models and manufacturers require submittal and pre-approval by The Ohio State University Utilities Division.

END OF APPENDIX U