

UNIVERSITY OF ROCHESTER
UNIVERSITY FACILITIES AND SERVICES
DISTRICT HOT WATER HEATING AND ENERGY TRANSFER STATION
STANDARD 232200

Revision 4
August 13, 2014

This is the most current document for this topic. Any deviations from the recommendations contain within must be approved by the Director of Central Utilities

This document provides technical information that states the design parameters for the mechanical system contained in a district heating energy transfer station. The information is specific to the new Low Temperature Hot Water (LTHW) district heating system located at the University of Rochester, New York.

The purpose of the energy transfer station is to transfer the energy transported from the Cogeneration plant through the distribution network to the building secondary systems to satisfy their heating needs.

- Section 1. Generally defines the LTHW district heating system and the terminology used throughout the document. A listing of authorities that have published codes and standards relating to building interconnection design and construction have also been furnished. The Design Engineer must review all applicable documents as part of the design phase of the work. Specific references to material, equipment, and other system components made in Section 5 are believed to meet these applicable codes. It is, however, the Design Engineer's responsibility to verify compliance prior to the preparation of final design documents.
- Section 2. Design Overview and Concepts are for the connection of new as well as existing buildings based on what the district heating system is capable of delivering. This section describes the system parameters and configurations for the Energy Transfer Stations. The Design Engineer must review the specific building supply and return temperatures prior to final equipment selection.
- Section 3. Describes the district heating (primary) side responsibility in regards to equipment, material, start-up, and commissioning.
- Section 4. Describes responsibilities in regards to equipment, material, start-up, and commissioning.

- Section 5 Specification on energy transfer station component material. Equipment Specifications will aid the Design Engineer in equipment selection. Components covered in this section are piping and pipe fittings, insulation, valves, energy metering elements, heat exchangers, controls, and operations.
- Section 6. Design Review, outlines requirements for periodic progress reviews of the Owner and Engineer for design acceptance.

1. General

1.1. System Description

This document describes the design parameters, configurations, materials, equipment and work that apply to the LTHW district heating (DH) system and what is required to connect buildings to this service.

University of Rochester, Central Utilities will provide low temperature hot water service to the buildings from a central cogeneration plant located at the Central Utilities Plant between River Campus and the Medical Center. The hot water is to be distributed to designated buildings from the plant through a buried distribution piping system.

The District Heating system will employ a flow and supply water temperature strategy that will vary both parameters based on outside air temperature and load demand. Each building will be connected to the distribution system indirectly through an energy transfer station. The actual load delivered to each building is controlled by modulating motorized control valve(s) located on the distribution system side (or LTHW district heating side) of the energy transfer station.

1.2. Definitions

Heating Design Pressure — The design pressure will be the maximum allowable working pressure as defined in ASME B31.1 Power Piping Code.

Operating Pressure — The operating pressure is the pressure at which the system normally operates.

Service Line (pipe) — The service lines run from the individual building interior wall to the energy transfer station heat exchangers. A set of isolation valves are normally installed where the service line penetrates the building wall. The energy transfer station heat exchanger flanges on the building side represent the point of delivery.

Energy Transfer Station — The energy transfer station (ETS) is an interconnection between the DH system and the building hot water heating and domestic hot water systems. The ETS is an indirect connection to the building secondary system. The ETS consists of isolation and control valves, controllers, measurement instruments, energy meter (s), heat exchanger(s), pipe, pipe fittings, and strainers.

Interconnecting Pipe — The interconnecting pipes run from the main isolation valves inside the building wall to the ETS heat exchangers located in the building mechanical room.

Point of Delivery — The point of delivery is defined as the building side flanges of the ETS heat exchangers.

Heat Exchanger (HX) — The heat transfer equipment used in extracting heat from one system and passing it to another system. Heat exchangers are used between the district heating system at the designated building.

Control Valve — The control valve(s) for the ETS will be located in the return line on the LTHW district heating side of the heat exchanger. The number and size of control valves required will be dependent on the maximum and minimum flows for each building load, the turn-down capability without cavitation of the selected valve size, and the maximization of system controllability. The actuator on each control valve will be electric.

Energy Meter — The energy meter is made up of a flow meter, two matched pair of temperature sensors, and energy calculator/integrator. The meter will continuously display operating parameters (i.e. flow, demand, temperatures, etc) on the LCD screen. This information will be used for metering and billing purposes. The meters will be connected to the Ethernet based metering system.

Controller — Controls to be integrated into the existing remote control system.

Strainer — Strainers are required at both the hot and cold side inlets of all heat exchangers valves to protect the heat exchangers from any suspended particles and debris. The LTHW side strainers will also protect the control valves and flow meters.

Owner's Engineer — The entity hired by the Owner to provide continuity of design as well as oversee and review the work by the Design Engineer and Contractor.

Design Engineer — The entity that is responsible for the detailed and final design of the ETSs.

Contractor — The entity with whom the Owner has entered into the agreement.

Work — The entire completed construction or the separately identifiable parts thereof required to be furnished under the contract documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the contract documents.

Furnish — Supply and deliver to the project site, ready for unloading, unpacking, assembly, installation or similar activities.

Install — Activities at the project site, including unloading, unpacking, assembly, erection, placing, applying, cleaning and similar requirements.

Provide — Furnish and install, complete and ready for intended use.

1.3. Codes and Standards

The design, fabrication and installation of the ETSS will be in accordance with the laws and regulations of the City of Rochester and the State of New York and ASME Power Piping Code B31.1. The design engineer shall provide results of a B31.1 stress analysis for the Owner's review to document all piping stresses on the primary supply and return piping is at or below B31.1 code allowed stress for the design pressures and temperatures specified herein.

In addition, the ETSS will be designed and installed in accordance with the latest editions of the applicable Codes and Standards from the following authorities:

- American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- ASHRAE Energy Standards 90-80
- American Society of Mechanical Engineers (ASME)
- American Society of Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- American Water Works Association (AWWA)
- American Petroleum Institute (API)
- Instrument Society of America (ISA)
- Underwriters Laboratories (ULC)
- National Electrical Manufacturer's Association (NEMA)
- National Fire Protection Association (NFPA)
- American Standards Association (ASA)

2. Design Overview and Concepts

2.1. System Design Requirements

2.1.1. Summary of Design Conditions

Pipe Velocities¹:

Maximum water velocity in service lines 3-7 ft/sec

System Design Temperatures

LTHW Design Supply 248°F

Maximum LTHW Operating supply 225°F²

Maximum building secondary hot water supply 180°F³

Maximum building secondary hot water return 130°F³

Maximum domestic hot water supply 140°F

System Design Pressures:

ETS LTHW Side Design 232psig

LTHW Side Operating delta P (ΔP) 20-80 psi

Building secondary Side Design ≤ 232 psig

Building secondary Side delta P (ΔP) As required

2.1.2. Hot Water General

Optimization of the hot water distribution system delta T (ΔT) is critical to the successful operation of the Cogeneration plant. Therefore, the customer's ΔT must be monitored and controlled. In order to optimize the system ΔT and meet the building's hot water demand, the flow from the plant will vary. Varying the flow also saves pump energy for the LTHW system.

It is strongly recommended that hot water flow in the building's side be varied as well. Terminal units within the building connected to the hot water loop (i.e., air handling units, fan coils, perimeter baseboards, etc.) may require modifications so they operate with variable water flow (2-way control valves, etc.) thus ensuring minimum return water temperatures. New buildings should employ variable flow systems with 2-way valves only.

¹ Indicated velocities are recommended in accordance with ASHRAE pipe velocity criteria.

² Temperatures will be reset based on outside air temperature for energy conservation purposes. The coolest water possible will be delivered to the building that will still meet the building's heating criteria and needs.

³ Temperature reflects new building design. Temperatures for existing buildings to be determined on an individual building basis in agreement with the owner or owner's engineer. Temperatures will be reset based on OAT for new and existing buildings.

The energy calculations shall be performed via the energy meter based on input from the flow meter and two temperature sensors.

2.1.3. Temperatures

Daytime LTHW district heating supply (DHS) water temperature from the cogeneration plant on peak design days will be 225°F. The supply temperature may be reset as low as 160°F when the outside air temperature is high (summer time) and conditions permit. The LTHW district heating return (DHR) water temperature will be a maximum of 170°F for existing buildings and maximum 150°F for new buildings.

2.1.4. Pressures

The DH distribution system is designed for a maximum allowable working pressure of 232psig. Equipment (valves, fittings, etc.) installed for the ETS locations will, where applicable, be selected to minimum ANSI Class 300. The ΔP at each service connection will vary with its location in the distribution system.

These pressures typically include an estimate for 5-10 feet interconnecting piping pressure drops downstream of the main isolation valves. A minimum of 15 psi will be allocated for the critical application which includes the ETS equipment and interconnecting piping. Buildings closer to the Cogeneration plant may be able to support a higher allowable pressure drop. Final calculation of all internal pressure drops are the responsibility of the Design Engineer.

2.1.5. Hot Water Control Parameters

As stated previously, the LTHW supply temperature may vary between 225°F and 160°F, and the maximum target (blended) DH return temperature is estimated to approach 155°F or less during peak conditions. The supply water temperature will be lowered outside the peak conditions for the purpose of conserving energy and optimize the power generated. To achieve a 155°F DH return temperature (or lower), the building return temperature must be no higher than 165°F (based on a 10°F approach heat exchanger on the return side) for existing buildings and not higher than 130°F for new buildings. The objective of the control system is to provide as cool a supply temperature as possible that will still meet the building's capacity requirements while maximizing the ΔT between the district heating supply and return (DHS&R) distribution piping.

The maximum return water temperature is based on the pressure/temperature of the generator turbine condensing section. Higher temperatures will reduce the efficiency of the cogeneration cycle.

2.1.6. Control & Measuring Equipment Performance

Each ETS will have a control panel responsible for the following:

- Calculating energy consumed at each ETS.
- Maintaining proper temperature relationships between the LTHW system supply and each building. It is recommended to use two control valves i.e. 1/3 – 2/3rd split range for flow rates ≥ 80 gpm for large turn down.

2.1.7. Meter Selection

Ultrasonic flow meters will be used at each building ETS. Magnetic flow meters have low pressure drops, good rangeability and accuracy while requiring very little maintenance.

2.1.8. Heat Exchanger Selection

Heat exchangers will be used on connections to all buildings. The optimum selection of each HX will be analyzed on the basis of:

- Sizing each unit's capacity to match load and load turn-down as close as possible.
- Critical nature of the load/operation.
- Temperature and pressure conditions.
- Available space in mechanical room.
- Allowable ΔP on both sides of HX.
- Braze Plate heat exchangers or double-wall plate & frame (for domestic hot water) are recommended for this application⁴. Braze plate type preferred where sizing allows its use.

The following table summarizes the selection criteria:

⁴ Shell & Coil heat exchangers are an acceptable alternate for selected systems (i.e. dual temperature or other systems configured for heating and cooling e.g. 2-pipe systems).

Space Heating Heat Exchanger Selection Criteria ⁵					
Hot Side Conditions			Cold Side Conditions		
Inlet Temp	Outlet Temp	Max. ΔP	Inlet Temp	Outlet Temp	Max. ΔP
225°F	140°F	3 psig	130°F	180°F	5 psig ⁶

Each HX will be sized for a maximum 10°F approach on the hot side (DH side) outlet to cold side inlet. Since the hot side outlet of the HX should not exceed 140°F, a cold side (building) return temperature of 130°F or lower is desired. This ensures optimal ΔT control for proper operation of the Cogeneration plant. Higher building return temperatures and ΔTs will have an adverse impact to the overall system operation and performance.

Existing building HX design conditions are to be determined by the Design Engineer on a building specific basis. The objective is to select the HX to achieve a maximum hot side outlet temperature of 170°F.

Domestic Hot Water Heat Exchanger Selection Criteria					
Hot Side Conditions			Cold Side Conditions		
Inlet Temp	Outlet Temp	Max. ΔP	Inlet Temp	Outlet Temp	Max. ΔP
225°F	140°F	3 psig	40-60°F	140°F	7 psig

The design pressure on the hot side (LTHW) of the HX will be 232 psig. On the cold side, the design pressure will be determined by the building hot water system pressure. For domestic hot water the use of a ‘self-contained’ heat exchanger skid with three-way control valve and circulation valve on the domestic hot water side is recommended for tight control.

⁵ Relates to new building design conditions.

⁶ May vary at each building location. Existing building allowable pressure drop to be reviewed on a case-by-case basis. Generally, since existing pumps are expected to be reused, the pressure drop should be selected to match the pressure drop of existing steam converters (which are normally ≤ 3.5 psi).

2.2. Make-up Water

University of Rochester will provide the make-up water requirements for the LTHW system. All necessary water treatment will be accomplished at the Cogeneration plant. (In buildings, in the secondary loop, domestic water shall be used for make up to the building closed loop with the roper back flow prevention.)

2.3. Commissioning

Described in item 3.5.

2.4. Hot Water Expansion

The thermal expansion of water in the LTHW primary (cogen) side system will be provided for at the Cogeneration plant.

3. Design Guidelines

3.1. ETS (Energy Transfer Station) Location

The design will provide suitable space for the installation of the LTHW system ETS equipment. This will include space for the service lines and interconnecting pipes. The ETS room shall be ventilated as required by Code and heated during the winter to minimum 60°F. The ETS room shall be located at the basement or ground level, preferably at or adjacent to an outside wall. Due to accessibility considerations in the LTHW systems, any proposed location of the ETS above ground level is to be approved by the Director of Central Utilities.

3.2. Equipment

The design will provide all interconnecting piping, isolation valves, strainers and other components, etc. (point of delivery) to the heat exchangers for the building system. The design will furnish threadolets (with female threads) in the secondary supply and return piping to accommodate the installation of temperature sensors. Refer to attached schematics in Appendix A, details #3, #1 and #12 and Detail A.

3.3. Building Modifications

The design will provide building modifications (as per University of Rochester's Central Utilities recommendations) necessary to optimize the building's existing steam, and hot water system. A good operating building system will benefit the University of Rochester.

For hot water, the modifications involve measures that decrease building's hot water return temperature to a maximum of 165°F. Typical building system modifications include; the replacement of 3-way valves with 2-way valves and the addition of variable speed pumping to the circulating system.

3.4. Make-up Water

Each building secondary heating system will provide for filling and managing the building water system.

University of Rochester– Central Utilities requires that the water treatment for the building system meet the minimum criteria set forth below. Corrosion coupons located in a 3-position, steel pipe corrosion coupon rack shall also be installed with a 316 ss, carbon steel and copper corrosion coupons to monitor corrosion rates.

- Maximum 50 ppm chloride for 304 SS (Heat Exchanger Plate Material)
- Maximum 250 ppm chloride for 316 SS
- Maximum 5% Nitrate for 304 SS & 316 SS

- Hardness ≤ 2 ppm
- PH Level 9.0-9.5
- Total bacteria count ≤ 100 cfu/ml.

3.5. Commissioning

Prior to the commissioning of the LTHW system, the system will be flushed. The strainers on the building's side shall also be cleaned. University of Rochester–Central Utilities will only allow the heat exchangers to be connected to the building's side once the proper strainer screen and mesh have been installed at the inlet to the heat exchanger (s). Y-strainers shall be installed at both inlets to the HX to protect against small debris and particulates. The strainers shall be fitted with 5/32" stainless steel perforated screen with 30⁷ mesh.

The project will employ the services of a water treatment subcontractor to provide the necessary chemicals, materials and supervision for a complete cleaning and flushing of all piping up to the heat exchangers to the point of connection to the building's hot water headers. After satisfactory water quality analysis results have been obtained (according to University of Rochester's water treatment contractor), system start-up and commissioning may occur. A certification from the water treatment contractor will verify that the water quality is acceptable.

FLUSHING

- A. Prior to hydrostatic testing, pipe system shall be flushed with fresh water until piping is free of dirt and foreign matter. Contractor shall provide all necessary hoses and connections between the domestic water system and the hot water system. Contractor shall be responsible for properly disposing of flush water.
- B. After flushing the piping, Contractor shall demonstrate main is free of debris with video camera inspection or other method approved by the Owner.
- C. Upon completion of the flushing process the contractor shall circulate commissioning chemicals in accordance with University of Rochester, Central Utilities as described below. The duration of the circulation shall be a minimum of a 48 hour duration. After acceptance of the pretreatment process the piping systems shall be drained, water used in the treatment process shall be captured and disposed of offsite in accordance with City of Rochester and County of Monroe regulations. A ten working day notification, request to be issued in writing, shall

⁷ 20 mesh for Shell & Coil heat exchangers,

be provided to Central Utilities prior to the commencement of the chemical treatment and filling process. The contractor shall provide a detailed plan outlining the proposed approach to accomplish this work. Central Utilities will have 5 working days to review and accept the plan. Once acceptance is issued the contractor can commence with the work.

Flush Sequence and Products:

- Fill system with clean domestic water with a pH from 7.0 to 10.
- Add Nalprep IV alkaline phosphate cleaner at 270 ppm. See chart below.
- Circulate for 48 hours
- Flush to within 1.0 ppm ortho phosphate and 1.0 ppm iron.
- Take sample to confirm.
- Circulate for 8 hours. Retest.

Nalprep IV Dosing

System Volume (gal)	Gallons of Nalprep
100	0.23
500	1.14
1,000	2.29
2,000	4.57
5,000	11.4
6,000	13.7
15,000	34.3

HYDROSTATIC TESTING

- A. After the pipe and all supports have been installed, but prior to applying thermal insulation, the complete piping system shall be subjected to hydrostatic pressure tests. The pipe shall be filled with clean, domestic water, which shall remain without external application of pressure for 24 hours before tests are conducted.
- B. Prior to hydrostatic testing, flush pipe system with fresh water until piping is free of dirt and foreign matter.

- C. Pressure shall be applied by a pump and measured by a calibrated test gage. The Contractor shall furnish all necessary apparatus and labor for conducting the pressure and leakage tests.
- D. The Contractor is responsible to ensure the release of air from the line during filling, as well as the prevention of collapse due to vacuum when dewatering the line.
- E. For pressure test, use a hydrostatic pressure not less than 1.5 x design pressure, or 348 psig. The duration of the test shall not be less than 4 hours. The pressure shall not vary by more than 5 psi for the duration of the test. The University's representative must witness and sign off on a suitable record of hydrostatic test.

3.6. Provisions for Water Expansion

Each building secondary hot water loop must have a suitable means for thermal expansion of the water in the hot water system. A suitable expansion tank is required based on the Design Engineer's calculations.

3.7. Changes to the System

The Contractor is not allowed to change or replace any equipment during the installation without approval from the Director of Central Utilities and Campus Planning, Design & Construction Management Project Manager on capital projects. Any future changes to the building's steam, and hot water system that will impact the DH system will be reported to and, when appropriate, approved by the Director of Central Utilities.

3.8. Asbestos Removal

Asbestos removal that is necessary for installation of the LTHW system will be the responsibility of the University for both testing and abatement.

3.9. City Water Service

The LTHW system is considered a non-potable water source.

4. Equipment Specifications

4.1. LTHW District Heating

4.1.1. Piping:

- .1 To ASTM A53/A106 electric resistance welded or seamless Grade B.
- .2 Up to and including NPS 2": Sch. 80, ERW or seamless, plain ends.
- .3 NPS 2 ½" and over: Standard Weight (Sch. 40), ERW or Seamless, beveled ends.

4.1.2. Fittings

- .1 NPS <2": Class 3000, forged steel screwed ends and socket weld ends, to ASTM A181.
- .2 NPS 2" and over: Standard Weight, forged steel, bevel ends, to A234, Grade WPB.

4.1.3. Couplings, Caps, Plugs

- .1 NPS ½" to 2" : Class 2000, screwed ends or socket weld ends, to ASTM A181.

4.1.4. Nipples for Drains, Vents, Pressure Gauges and Thermometers

- .1 NPS ½" to 2" : Sch. 80, screwed, to ASTM A53, Grade B.

4.1.5. Unions

- .1 Up to and including NPS 2": Class 3000; socket welded ends, forged steel, steel-to-steel ground joint, to ASTM A181.

4.1.6. Outlets for branch connections

- .1 Full Size; Standard Weight, welded tee, forged steel A234 WCB.
- .2 One size smaller; Standard Weight, welded reducing tee.
- .3 Two or more sizes smaller;
 - .1 NPS 2" and smaller – Forged carbon steel Thread-o-let or reducing tee.
 - .2 NPS 2 ½" and larger – Forged carbon steel Weld-o-let or reducing tee.

4.1.7. Flanges

- .1 All flanges to be ASTM A105 forged carbon steel, 300# class, ANSI B16.5 weld neck, raised face. Bore to match pipe schedule

4.1.8. Bolts and Nuts

- .1 Up to and including NPS 2": bolts, A193 B7 alloy steel, with carbon steel 2H heavy hex nuts, to ASTM A307, Grade B.
- .2 NPS 2 1/2" and over: Stud bolts, A193 B7 alloy steel, with carbon steel 2H heavy hex nuts, to ASTM A307, Grade B.

4.1.9. Gaskets

- .1 Flexitallic Type CG, 316 stainless steel/graphite suitable for maximum design temperatures and pressures, 300# rated flanges.

4.1.10. Joints

- .1 Pipe joints will be full circle butt-weld joints to ANSI/ASME B31.1 latest edition. No other welded joints will be allowed. Backing rings will not be allowed. TIG root pass and SMAW weld cap. Contractor to provide welding procedure and welder qualification records for Owner's review.

4.1.11. Isolation Ball Valves

- .1 NPS 1" to 8": Working Pressure 232 psig at 225 °F, schedule 40 (or 80) Butt Weld ends to match pipe, steel body, stainless steel ball and stem, Teflon seat, reduced bore, class 300. Lever actuator for valves up to and including NPS 6" within 8 ft. of floor. Provide gear operated actuator with handwheel for valves NPS 8" and above and chain wheel above 8 ft. Acceptable materials: Vexve, Broen Ballomax, Bohmer.

4.1.12. Drain and Air Vent Valves

- .1 NPS 1/2" to 3/4" : carbon steel barstock body, 316 stainless steel ball and stem, threaded ends, RTFE seats and seals, blow-out proof steam design, lever handle, rated for 150 psig steam service. Acceptable material: Apollo 72-900 or 72-100

4.1.13. Needle Valves

- .1 NPS 3/8" to 3/4": Threaded, union bonnet, carbon steel body, needle type seating, 9,200 psig non-shock water, at 400 °F. Acceptable Material: Kerotest

4.1.14. Safety Relief Valves

- .1 Safety relief valves are only needed on the secondary loop side, not on the primary side.
- .2 Safety relief valves shall be ASME rated direct spring loaded type, lever operated, non-adjustable factory set discharge pressure.
- .3 Each valve shall be drained separately to floor drain.
- .4 System relief valve capacity shall exceed make-up capacity.
- .5 Valves provided with owner purchased equipment or as noted on the drawings. Equipment relief valve capacity shall exceed input rating of connected equipment.
- .6 Acceptable Material: Watts, Lonergan

4.1.15. Pressure and Temperature Gauges

- .1 The heat exchanger shall have inlet and outlet pressure gauges and temperature indicator on both the cogen (primary) side and secondary (building) side.
- .2 Pressure gauges shall have a needle or ball valve isolation not less than 1/2" NPS.
- .3 Pressure gauges shall have a 4-1/2" dial size, 0-300 psi range, 316 stainless steel internals. Ashcroft, Terrice or equal.
- .4 Temperature indicators shall be 4-1/2" dial size with a range of 40 to 300 degrees F. A 316 inch thermowell shall be provided for the temperature sending element using a suitable 300# threadolet. Ashcroft, Terrice or equal.

4.1.16. Strainer

- .1 NPS 2" and smaller: Cast steel, Y-pattern, socket weld ends, mesh size shall be 1/50", Class 300 for 232 psig and 225 °F. Acceptable materials: Spirax CT.

- .2 NPS 2 ½” and over : Steel body, Welded, Ends to match pipe, Y-pattern, stainless steel perforated screen with 1/50” mesh and complete with valve drain piped to 1 foot above floor and equipped with hose end connection. Screen area shall be minimum three times area of inlet pipe and mesh shall be 1/50”. Class 300 for 232 psig and 248°F. Acceptable Materials: Spirax Sarco, SSI Equipment Inc.

4.1.17. Brazed Plate Heat Exchanger – Space Heating

- .1 Heat exchangers shall consist of thin corrugated Type 316 stainless steel plates stacked on top of each other and brazed together. Brazing material shall be copper. Every second plate shall be inverted so that a number of contact points are created between the plates. The plate patterns are to create two separate channels designed for counter flow. Plate thickness shall be of a minimum of 1/64”.
- .2 The plate pack shall be covered by Type 316 stainless steel cover plates.
- .3 The flanged (or threaded) connections shall be located in the front or rear cover plate. Flanged nozzle connections shall conform to ANSI standards, and shall be of the pressure rating design indicated below.
- .4 Heat exchangers shall be supplied with removable insulation kits and supports (stands, brackets etc.). The insulation shall consist of freon free insulation (polyurethane foam) and ABS plastic cover.
- .5 The heat exchangers shall be designed for the following continuous operating pressures and temperatures:
 - .1 **232 psig and 248°F, hot water**
- .6 The heat exchanger characteristics shall be as per the attached schedule.
- .7 Standard of Acceptance: Alfa Laval, ITT, Sondex or equivalent.
- .8 The heat exchanger shall be bolted to the floor on a 4” high concrete pad.
- .9 Where serving a glycol secondary loop, all heat exchangers must be double wall construction.

4.1.18. Shell & Coil Heat Exchanger – Space Heating (with Central Utilities approval only)

- .1 The heat exchangers shall be designed and fabricated as a single unit with non-removable parts. The cylindrical shell shall enclose a tube bundle, which consists of circular layers of helically, corrugated tubes.

- .2 The coiled tube bundles shall be welded to a compact tube sheet located within the entry and exit connections. The cylindrical shell shall be terminated by hemi-spherical heads.
- .3 The coil material shall be 316L stainless or copper. The shell material shall be 316L stainless steel.
- .4 Flanged nozzle connections shall conform to ASA standards, and shall be of the pressure rating design indicated below.
- .5 Heat exchangers shall be supplied with removable insulation kits and supports (stands, brackets etc.).
- .6 The heat exchangers shall be designed for the following continuous operating pressures and temperatures:
 - .1 **Coil (Hot) Side: 232 psig and 248°F, hot water**
 - .2 **Shell (Cold) Side: 150 psig and 248°F, hot water.**
- .7 The heat exchanger characteristics shall be as per the attached schedule.
- .8 Standard of Acceptance: Secespol SEC, ITT or equivalent

4.1.19. Double Wall Plate & Frame Heat Exchangers – Domestic Hot Water

- .1 For domestic hot water service a Cemline double wall, brazed plate packaged heater exchanger skid is recommended for tight temperature control of the domestic hot water supply to the building. This factory assembled skids feature a circulation pump on the domestic water side to insure a minimum flow across the Heat exchanger. A two way control valve on the primary side is used to control domestic hot water temperature. This valve must meet the design pressure and temperature requirements and provide tight shutoff against the hot water system design differential pressure.
- .2 Connections shall be NPT, male threads or flanged. Flanged connections shall conform to ANSI standards.
- .3 The double wall plates shall compose of two plates pressed together simultaneously and laser welded at the port. Failure of one plate or weld shall result in an external detection without inter-leakage. The plates shall be corrugated Type 316 stainless steel. Metal to metal contact shall exist between adjacent plates. The plates should have no supporting strips and should be pressed in one step. The part of the plate in contact with the carrying and guiding bars shall be reinforced to prevent bending and twisting during the handling of the plates. The plates shall be fully supported and fully steered by the carrying bar and guided by the guide bar to prevent misalignment in both vertical and horizontal directions. Plate design shall permit the removal of any plate in the pack without the need to remove all of the other plates ahead of it. Plate thickness shall be of a minimum of 1/64”.

- .4 Gaskets, if non-brazed plate, shall be clip-on or snap-on (glue-free) EPDM. The gaskets shall be in one piece, as well as one piece molded, in a groove around the heat transfer area and around the portholes of the plates. The gasket groove shall allow for thermal expansion of the gaskets. The gaskets shall have a continuous support along both its inner and outer edges and to prevent over-compression of the gaskets.
- .5 Brazed plate heat exchangers shall be supplied a painted steel, rigid base plate and be mounted on a 4" high concrete housekeeping pad.
- .6 The heat exchangers shall be designed for the following continuous operating pressures and temperatures:
 - .1 **230 psig and 248°F, hot water.**
- .7 Standard of Acceptance: Cemline BPH or equal..

4.1.20. Insulation

The DH system will supply hot water at a temperature of 225°F during peak design days. With this temperature profile, will have to be insulated thoroughly to provide stable insulation over the long-term.

4.1.21. P-1 Formed Mineral Fiber 85°F to 400°F

- .1 Application: for piping, valves, and fittings on all hot piping. This Piping includes:
 - .1 All interior District Heating Primary Piping, temperature 248°F (120°C).
 - .2 Hot Water Heating, Temperature 190°F
 - .3 Domestic Hot Water, Temperature 140°F
- .2 Materials:
 - .1 ASTM C547, rigid mineral fiber unjacketed for piping.
 - .2 Acceptable materials: Schuller Micro-lok Plain, Manson, FIBERGLAS.
- .3 Thermal Conductivity "k" shall not exceed 0.02 Btu/hr, ft, °F at 75°F mean temperature when tested in accordance with ASTM C335. Thickness as per the attached table.

FLUID TEMP°F	NOMINAL PIPE SIZE (NPS)			
	≤1"	1.25" - 2"	2.5" - 4"	≥5"
301 – 400	2.5"	2.5"	3"	3.5"
251 – 300	2"	2.5"	2.5"	3"
204 – 250	1.5"	1.5"	2"	2"
121 – 203	1"	1"	1.5"	1.5"
85 – 120	1"	1"	1"	1"

.4 Note: Use insulation thickness corresponding to supply temperature 301°F - 400°F for all exterior/outdoor piping and/or unheated spaces.

- Thickness of hot water piping insulation sized to provide personnel safety (anti-scald) to below 105°F regardless of jacket material.
- All piping will be suitably identified as to the media contained. Any hot water piping installed on the exterior of a building shall have an insulation thickness corresponding to 303-392°F and
- Jacketed entirely in aluminum.

4.1.22. Removable Thermal Blanket Insulation

- .1 Asbestos Free removable thermal blanket insulation to withstand temperatures up to 1000°F (538°C), sewn design, and provided with the minimum insulation listed below.
- .2 2" thickness to be used for flanged valves, strainers, pump housings, flow meters, domestic hot water heat exchangers, control valves, and flexible connections, if applicable, on the following systems:
- .3 LTHW District Heating Primary Piping, Temperature 248°F
- .4 Hot Water Heating, Temperature 200°F
- .5 Domestic Hot Water, Temperature 140°F.
- .6 Acceptable materials: INSULTECH

4.1.23. Removable Insulation Enclosures

- .1 Flexible or preformed insulation enclosures to fit components complete with vapor barrier. Thickness to match piping insulation thickness.
- .2 In lieu of wrapping heat exchangers, valves, flanges, etc., with blanket insulation, pre-formed glass fiber fitting insulation may be used. Cover fitting insulation with the same sectional pipe insulation jacket material laminated in place with adhesive.
- .3 Jacket to match adjacent pipe.
- .4 Designed to permit easy removal and replacement without damage to adjacent insulation
- .5 Provide on DHW heat exchangers.

4.1.24. PVC Jackets

- .1 Are generally required for all “exposed” piping as per definition below. The exact extent of the PVC jacket requirements to be determined by the Design Engineer and approved by the Owner. For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.

4.2. Controls & Measuring Equipment

4.2.1. Description

- .1 Extend existing Direct Digital Control System, to perform the functions described in this Section. All new equipment shall be compatible with the existing system. Provide wiring and conduit required to connect devices furnished as a part of, or accessory to, this automatic control system. Install wiring in accordance with requirements in Section 16010, and the National Electrical Code. Provide all required devices for proper system operation, including special electrical switches, transformers, relays, pushbutton stations, etc.
- .2 Control contractor to provide all wiring and conduit required for the energy meters supplied by the project as described in item 4.2.11 or as approved by the Director of Central Utilities.

4.2.2. Acceptable Makes

- .1 The complete control system is designed and based on that manufactured by Automated Logic Controls, Siemens Building Technologies or Andover Controls. Acceptable System Manufacturers: Siemens Building Technologies, Automated Logic Controls or Andover Controls.

4.2.3. Products

- .1 The controls supplier shall select the appropriate control component to match the required service conditions. The control valves type selected shall meet the minimum design requirements described in the following sections.

- .2 The minimum test for control valves and flow meters shall be hydrostatic test in strict accordance with the requirements of ASME Section VIII, Division 1, or Section III, Class 3. Hydrostatic test pressure shall be 1-½ times the design pressure using calibrated pressure gauges.

4.2.4. Field Devices

- .1 All devices and equipment shall be approved for installation by the University of Rochester.
- .2 Control Valves:
 - .3 Sized by control supplier according to design specification herein. Water valves shall be sized on the basis of min. 50% of available differential pressure or min. 12 psi pressure drop. Pressure drop for valves shall be submitted for review, including all CV values.
 - .4 Valves shall be equal percentage type, two-way, single-seated, equipped with characteristic type throttling plug, #316, stainless steel stem. Provide with necessary features to operate in sequence with other valves and adjustable throttling range as required by the sequence of operations.
 - .5 Valves in 2 in. and smaller shall be screwed bodies; 2-1/2 in. and larger shall be flanged bodies; designed for 250 psi operating pressure.
 - .6 Valves shall be able to handle a minimum of 80 psi differential pressure for modulating service with range ability greater than 100:1. Actuator selection shall be for close-off pressures greater than 100 psi. Arranged to fail-safe as called for; tight closing and quiet operating.
 - .7 Leakage must be less than 0.1% of CV.
 - .8 Valves shall have Teflon packing.
 - .9 Electric Actuators (Valve):
 - .10 Provide 24 VAC control valve actuators which are 0-10 VDC or 4-20 mA input proportional with spring return as needed by control sequence and designed for water service valve bodies. Operator shall be synchronous motor driven with up to 150 in. lb. force and force sensor safe.
 - .11 Control stroke time shall be less than 30 seconds

- .12 Actuator shall include a manual clutch that enables manual positioning of valves during power failures and servicing.
- .13 Upon restoration of power, actuator will automatically reposition itself without intervention.
- .14 Actuator shall have self-lubricating bearings to minimize maintenance requirements.
- .15 Indication of position shall be visible at all times.
- .16 Acceptable Make: SIEMENS SKB/SKC, Belimo or equal.
- .17 Safety/Status Devices:
- .18 Pump status shall be provided through adjustable range current sensing element on pump motor.
- .19 Miscellaneous Devices:
- .20 Provide necessary, relays, transformers, accumulators, three-way air valves, positioners, pneumatic electric switches, air switches, required for a complete and operable system.
- .21 Locate these devices in a separate panel unless specified otherwise.

4.2.5. Control Cabinets

- .1 Central DDC control panels shall be fully enclosed cabinet, baked enamel, steel, aluminum or composite material construction and shall meet the requirements of NEMA 1 enclosures. Panels shall have hinged door with a locking latch. Cover exposed electrical connections. Each component on front panel shall have an appropriate engraved label describing its function. Components inside the panel shall be appropriately labeled for ease of identification. Stick-on labels are not acceptable. Panels shall be either free-standing or wall-mounted. Provide support steel framing.

4.2.6. Direct Digital Control System

- .1 The basic elements of the Direct Digital Control System structural shall consist of standard components kept in inventory by the equipment supplier. The components shall not require customizing other than setting jumpers and switches, adding firmware modules or software programming to perform required functions. The system may be expanded to its full capacity by adding sensors and entering programs in available random access memory (RAM). Future expansion shall not require hardware modifications to the

controller. The entire system shall be a Direct Digital processing type with pneumatic output devices.

- .2 The DDC system shall consist of the following:
 - .1 Application specific controllers (ASCI).
 - .2 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel (Central or ASC) shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

4.2.7. Energy Metering Components

- .1 The energy meter is made up of a flow meter, two temperature sensors, energy calculator, and plug-in modules. A read-out unit makes it possible for the operator to observe the operating parameters. The energy meter shall be furnished with an output (e.g. M-Bus, BacNet) for remote communication to the university's PI Systems based metering system. The energy meter shall be installed on the return piping side of the heat exchanger. Reference the utility metering standard 330000.
- .2 Energy Calculator
 - .1 Material
 - .1 Integrator top: SAN
 - .2 PCB casing: ABS
 - .3 Connection unit and bracket: PP
 - .4 Gaskets: Sarlink 3150B
 - .5 Complies with test: OIML R75 and EN1434
 - .2 Performance
 - .1 Accuracy: +/- (0.15+2/ Δt)%
 - .2 Range: 1 $^{\circ}\text{C}$ – 160 $^{\circ}\text{C}$ (34 $^{\circ}\text{F}$ - 320 $^{\circ}\text{F}$)
 - .3 Flow Calculation: 30s intervals
 - .3 Design and Fabrication
 - .1 Power supply: 24 VDC
 - .2 Memory: EEPROM
 - .3 Display: LCD with back light
 - .4 Ambient Temperature Range: 0 $^{\circ}\text{C}$ (34 $^{\circ}\text{F}$) to 55 $^{\circ}\text{C}$ (131 $^{\circ}\text{F}$)
 - .5 Plug-in modules

- .4 Display Features
 - .1 Accumulated thermal energy: MWh and/or MMBtu
 - .2 Accumulated water flow: m³ and/or gallons
 - .3 Actual thermal power: kW and/or MBtuh
 - .4 Actual water flow: l/h and/or gpm
 - .5 Supply temperature: °C and/or °F
 - .6 Return temperature: °C and/or °F
 - .7 Peak thermal power: kW P and/or MBtuh P
 - .8 Peak water flow: l/h P and/or gpm P
 - .9 Hour Counter: HRS
- .5 Factory calibrated
- .6 Approvals
 - .1 Complies with test: OIML R75 and EN1434
 - .2 Factory supplied verification certificate.
- .3 Magnetic Flow Meter (Hot Water)
 - .1 Acceptable Manufacturers are Rosemount, Onicon and Yokogawa. Reference the utility metering standard 330000.
 - .2 Materials:
 - .1 Flow Tube: AISI Type 304 SS.
 - .2 Flanges: Carbon Steel.
 - .3 Housing: Carbon Steel.
 - .4 Paint: Polyurethane.
 - .5 Lining: PTFE Teflon.
 - .6 Electrodes: 316L SS.
 - .7 Grounding Rings: 316L SS.
 - .3 Performance
 - .1 Accuracy: +/- 1.0% of rate within flow range of 1 to 30 ft/s.
 - .2 Minimum Rangeability: 1:30.
 - .4 Design and Fabrication
 - .1 Process Connections:
 - 2 inch and smaller: Threaded supplied with unions for male NPT
 - 2-1/2" and larger: ANSI Class 150 flanged
 - .2 Ambient Temperature Range: 0 °C to 60 °C (32 to 140°F)
 - .3 Fluid Temperature Range: 40 to 248 °F.
 - .4 Fluid Pressure Range: Full vacuum to 232 psig.

- .5 Factory calibrated
- .6 Standard of Acceptance: Rosemount, Onicon or, Yokogawa
- .4 Resistance Temperature Detectors (RTDs)
 - .1 Materials:
 - .1 Sensor Insert: 304 SS
 - .2 Connection Head: Aluminium, MS58Pb
 - .3 Thermowell: 304 SS, W-n0. 1.4301
 - .2 Performance:
 - .1 .04 °C Δt deviation (pairing)
 - .3 Design and Fabrication:
 - .1 4-wire PT500 Pocket Sensor (Paired) with connecting head.
- .5 Remote Communication Output (e.g. M-Bus, BacNet) module for the following data:
 - .1 Accumulated thermal energy: MWh and/or MMBtu
 - .2 Accumulated water flow: m³ and/or gallons
 - .3 Actual thermal power: kW and/or MBtuh
 - .4 Actual water flow: l/h and/or gpm
 - .5 Supply temperature: °C and/or °F
 - .6 Return temperature: °C and/or °F
 - .7 Peak thermal power: kW P and/or MBtuh P

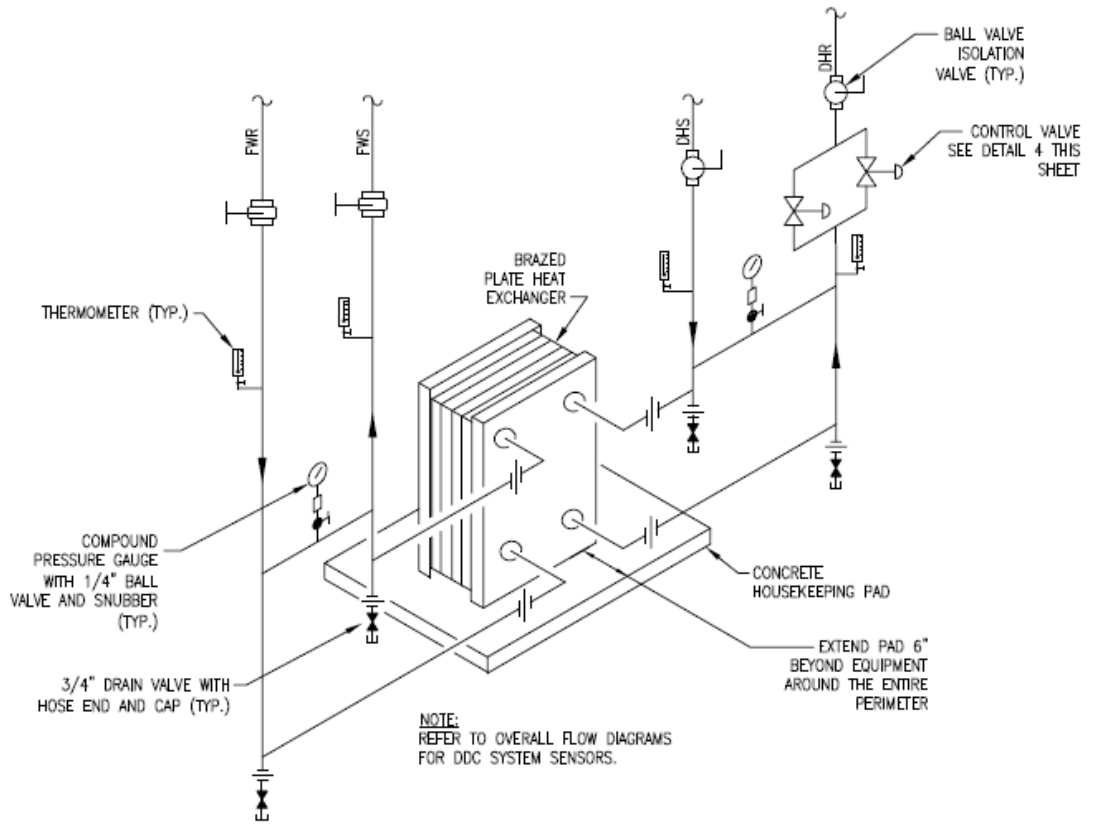
4.2.8. Sequence of Operations

- .1 General
 - .1 The controls contractor to program the added control points to conform, at a minimum, to the sequence of operation indicated below.
 - .2
The control strategy and sequence of operations will be determined in conjunction with the controls contractor and Central Utilities-Energy Operations Group. The general control strategy to be implemented for the new Energy Transfer Stations shall be similar to the existing with the supply temperature reset based on the outside air temperature. In addition, a reset function based on return temperature shall be added to ensure that the district heating return temperatures are maintained as low as possible.

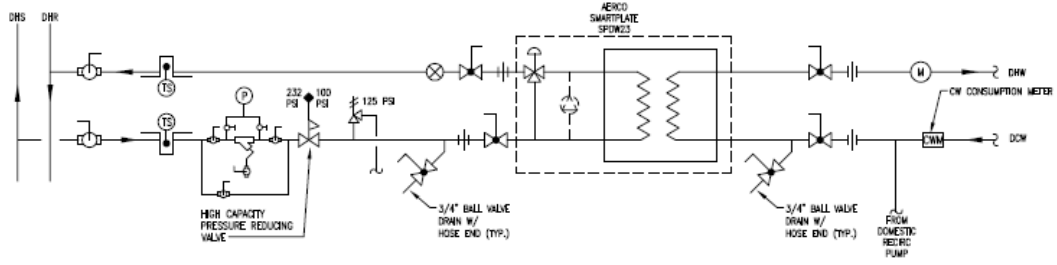
.2 Standard Heating Supply with Return Limiting

- .1 During normal operation, the secondary supply temperature shall be set from a temperature reset schedule based on outside air temperature (OAT). The schedules are to be system specific, and shall generally conform to the current reset schedules. The controls for the existing steam converters will be abandoned.
- .2 The secondary return temperature shall not exceed the maximum return temperature limit. Should this happen, the supply temperature set point shall be reset down until the secondary return temperature drops below the maximum values. The return water limiting function shall override the minimum supply temperature function. The maximum return limit will be building specific.
- .3 The DDC system shall monitor hot water supply and return temperatures. If temperatures exceed high or low limits, an alarm shall be recorded at the operator's workstation.

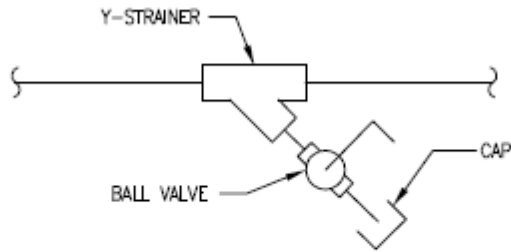
5. Appendix I – Typical Heating Energy Transfer Station Schematics



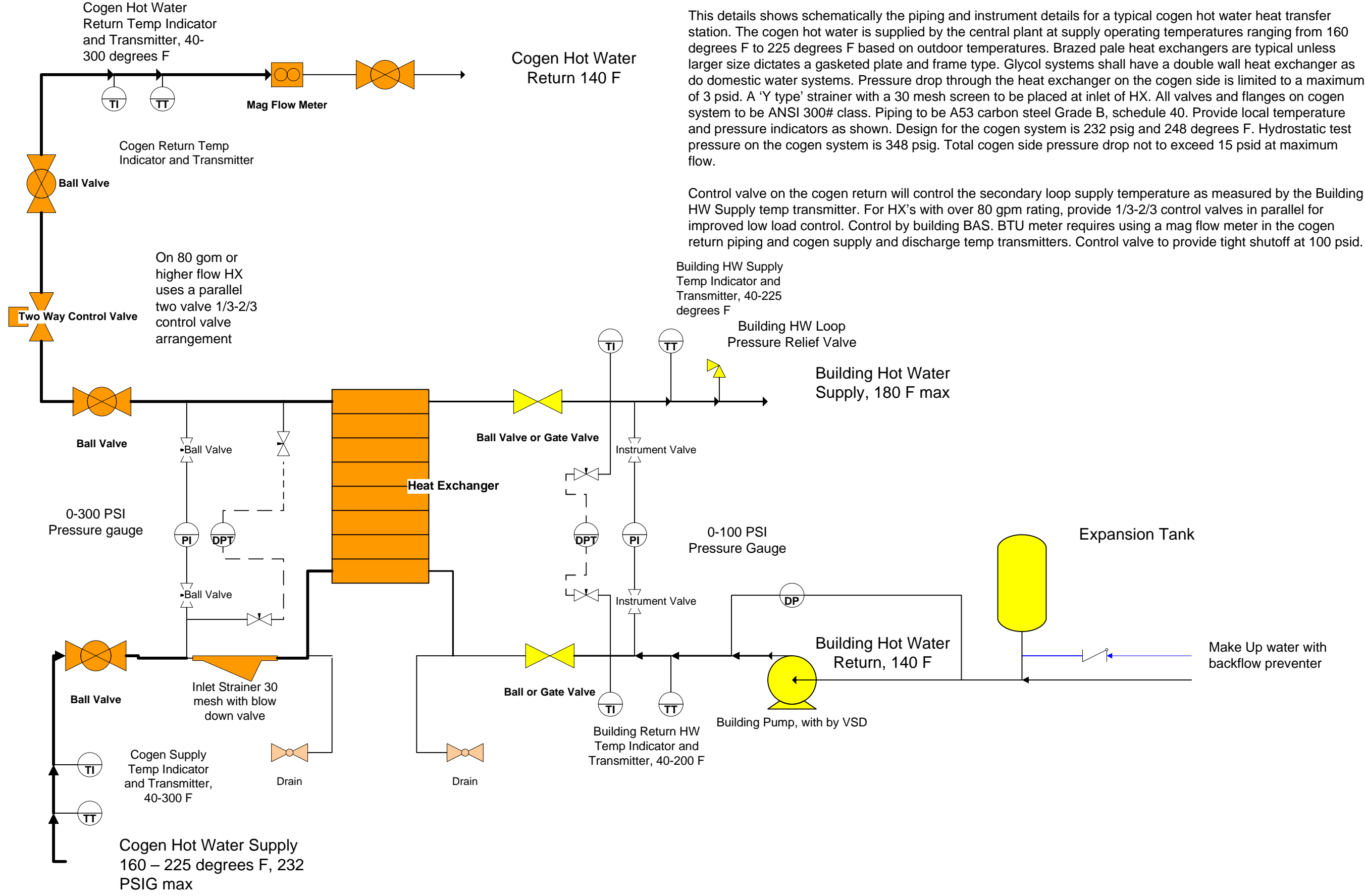
3 **TYPICAL FEEDWATER HEAT EXCHANGER DETAIL**
SCALE: NONE



1 DOMESTIC WATER HEATER PIPING DIAGRAM
SCALE: NONE



12 Y- STRAINER DETAIL
SCALE: NONE



This details shows schematically the piping and instrument details for a typical cogen hot water heat transfer station. The cogen hot water is supplied by the central plant at supply operating temperatures ranging from 160 degrees F to 225 degrees F based on outdoor temperatures. Brazed plate heat exchangers are typical unless larger size dictates a gasketed plate and frame type. Glycol systems shall have a double wall heat exchanger as do domestic water systems. Pressure drop through the heat exchanger on the cogen side is limited to a maximum of 3 psid. A 'Y type' strainer with a 30 mesh screen to be placed at inlet of HX. All valves and flanges on cogen system to be ANSI 300# class. Piping to be A53 carbon steel Grade B, schedule 40. Provide local temperature and pressure indicators as shown. Design for the cogen system is 232 psig and 248 degrees F. Hydrostatic test pressure on the cogen system is 348 psig. Total cogen side pressure drop not to exceed 15 psid at maximum flow.

Control valve on the cogen return will control the secondary loop supply temperature as measured by the Building HW Supply temp transmitter. For HX's with over 80 gpm rating, provide 1/3-2/3 control valves in parallel for improved low load control. Control by building BAS. BTU meter requires using a mag flow meter in the cogen return piping and cogen supply and discharge temp transmitters. Control valve to provide tight shutoff at 100 psid.

Detail A- Cogen Hot Water Typical Energy Transfer Station Details

Cogen Hot Water ETS Details
 Standard 232200 - Appendix A
 Detail A
 August 2014
 Central Utilities - sgm