

## 1.0 **GENERAL**

### 1.1 **Introduction**

- .1 The University of British Columbia has collated two reports that FVB (FVB Energy Inc.) prepared: Technical Design Basis Document – for Hot Water Energy Transfer Stations and for Hot Water Distribution Piping System. FVB prepared these documents to outline the design basis for the building connections of Energy Transfer Stations (ETS) and required building secondary side modifications for the conversion to a medium temperature hot water district energy system; as well as to outline the technical guidelines or design basis of the new hot water District Energy System (DES). This section will serve as the general technical reference guide on which all design would be based. No significant changes to this concept shall be made without the approval of UBC Energy and Water Services (EWS). DES pipe installation work is restricted to Logstor - trained and certified contractors only.

A copy of such certification must be attached to the bid.

### 1.2 **System Description**

- .1 The University of British Columbia (UBC) has a medium temperature hot water district heating system at the Vancouver (Point Grey) UBC North Campus.
- .2 The hot water is being distributed to each customer/building on the campus through a two-pipe (one supply and one return) buried distribution piping network. The hot water is used for building heating and domestic hot water heating. The purpose of the energy transfer station is to transfer the energy transported from any Heating Plant through the distribution network to the customer via heat exchangers to satisfy the buildings' heating needs. The energy transfer stations therefore replace the steam converters in existing buildings or the traditional boiler or furnace system and hot water heaters in new buildings. The building heating system design for new buildings is open to the designer as long as the system meets the basic requirements of the District Heating system.
- .3 The medium temperature hot water system operates at a maximum supply temperature of 120°C on peak design days and a maximum return temperature of 75°C. The design pressure for this system is 1,600 kPa.
- .4 The DH system employs a variable 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 customer is controlled by modulating motorized control valve(s) located on the distribution system side (or primary DH side) of the energy transfer station. This variable flow and temperature reset strategy is to aid in maximizing the efficiency of the entire system.

### 1.3 **Energy Transfer Station (ETS) Basic Equipment**

- .1 An energy transfer station is made up of heat exchanger(s), isolation valves, strainers, control package – including controller, control valve(s), temperature sensors, and energy metering package – including flow meter, temperature transmitters, and energy calculator.

### 1.4 **Definition**

- .1 **Building Energy Transfer Station (ETS)** – The building ETS is an interconnection between the DH system and the consumer's hot water heating and domestic hot water systems. The ETS is an indirect connection to the customers' systems via heat exchangers. The ETS consists of isolation and control valves, controllers, measurement instruments, an energy meter, heat exchanger(s), pipe, pipe fittings, and strainers.

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- .2 **Campus Energy Center (CEC)** – Main District Heating Plant located in its own building at the corner of Health Sciences Mall and Agronomy Road.
  - .3 **DH** – The District Heating system
  - .4 **DES- The District Energy System (same as above)**
  - .5 **Design Engineer** – The entity that is responsible for the design of the energy transfer stations or distribution piping system.
  - .6 **Design Pressure** – The design pressure shall be the maximum allowable working pressure as defined in ASME B31.1 Power Piping Code.
  - .7 **Development/Owner’s Engineer** – The entity hired by the owner to oversee and review the work by the contractor and Design Engineer.
  - .8 **Distribution Piping System (DPS)** – The network of main piping lines connecting the DH Energy Centre to the service line piping. The direct buried supply and return distribution lines for the hot water system will be Logstor prefabricated, pre-insulated steel pipes.
  - .9 **DHW** – Domestic Hot water
  - .10 **DPS Leak Detection System (LDS)** – Logstor designed System that consists of measuring sections and measuring instruments for surveillance of the integrity of the pipe system. The LDS is designed to detect moisture within pipe insulation, system deviations and disorders and the location of moisture and/or disorders.
  - .11 **Energy Meter** – The energy meter is made up of a flow meter, two matched pair of temperature sensors, and an energy calculator/integrator. The meter will continuously display operating parameters (i.e. flow, demand, temperatures, etc.) on the LCD screen. This information is used for metering and billing purposes. The meters are to be integrated with Owner’s ION metering system.
  - .12 **Heat Exchanger (HX)** – The heat transfer equipment is used in extracting heat from one system and passing it to another system. Heat exchangers are used between the DH system and the customer heating systems.
  - .13 **Heating Plant** – The District Heating source, to which the distribution network connects.
  - .14 **Interconnecting Pipe** – The interconnecting pipes run from the main isolation valves inside the building wall to the ETS heat exchangers located in the customer’s mechanical room.
  - .15 **Medium Temperature Hot Water (MTHW)** – Treated water used in the heating distribution and service line network. MTHW systems are designed for maximum design supply temperatures of 120°C.
  - .16 **Operating Pressure** – The operating pressure is the pressure at which the system normally operates.
  - .17 **Owner** – The entity, University of British Columbia (UBC), with whom the contractor has entered into the agreement and for whom the work is to be provided.
  - .18 **Service Line (pipe)** – The service lines run from the branch fittings on the main distribution pipes to a maximum of 3 meters inside the building wall. A set of isolation valves are normally installed at the point where the service line penetrates the building wall.
  - .19 **Strainer** – Strainers are required at both the hot and cold side inlets of all heat exchangers to protect the heat exchangers from any suspended particles and debris. The primary side strainers will also protect the control valves and flow meters.

## 1.5 Building Connections

- .1 The heating ETS for the customers will be designed so that each building can be “indirectly” connected to the main distribution system. This means that each building’s internal heating and domestic hot water systems (secondary side) are isolated from the DH distribution system (primary side) by means of a brazed plate (or double wall plate & frame for DHW) heat exchanger(s).
- .2 The basic ETS will consist of the isolating valves, heat exchangers, actuated control valves, a digital controller, and an energy meter. The controller is used to sense the heat load demanded by the building and satisfies the heating demand by modulating the two- way control valves located on the primary side return of the ETS. This modulating action allows either more or less heat to be made available for transfer to the building’s internal heating system.
- .3 New buildings must utilize a cascading of the space heating heat exchangers and domestic hot water (DHW) heat exchangers as this is beneficial to improve the return water temperatures.
- .4 General arrangement is found in Standard Documents (see 2.1.1). Also see Division 23, *Section 23 21 00 Hydronic Systems – Piping & Equipment*.

## 2.0 **GENERAL REQUIREMENTS**

### 2.1 **Responsibilities**

- .1 UBC Energy & Water Services (EWS) is primarily responsible for operation, maintenance, and overall stewardship of the district energy hot water distribution system. The demarcation of UBC Energy & Water Services point of service is normally up to and including the first isolation valve inside the building. Energy & Water Services also owns and maintains any energy meters.
- .2 New building design and construction, in regards to the District Heating System tie-in and the ETS configuration, must be coordinated with UBC EWS. UBC EWS must give approval of the consultants and contractors for the design, installation and commissioning of these systems.
- .3 Key positions in UBC Energy & Water Services are described in Division 33, Section 3300 10 Underground Utilities Services of UBC Technical Guidelines.
- .4 Unless otherwise agreed in writing, the project Designer is responsible for all design, permit, and inspection requirements of Technical Safety BC (TSBC) and all other regulatory bodies involved.
- .5 The project Designer must incorporate all specific requirements for metering, design and materials and execution of this section into the contract drawings in the form of job-specific notes. Only making reference to UBC Technical Guidelines in the drawings is not sufficient.
- .6 Shutdowns must be requested in writing adhering to UBC's campus-wide shutdowns procedures. Refer to Service Shutdown Request at <https://buildingoperations.ubc.ca/resources/policies-procedures-forms/>
- .7 Operating valves on the district hot water energy distribution system shall only be performed by UBC Energy & Water Services.

### 2.2 **District Hot Water Energy Distribution Standards and Policies**

- .1 DES Codes and Standards
  - .1 The design, fabrication and installation of the distribution system shall be in accordance with the laws and regulations of the Province of British Columbia, CSA B51 and ASME B31.1. All primary side ETSs must be designed and registered with Technical Safety BC. Stress analysis should be performed at 120°C for both supply and return piping.
  - .2 In addition, the distribution system shall be designed and installed in accordance with the latest editions of the applicable Codes and Standards from the following authorities:
    - British Columbia Building Codes, Technical Safety BC
    - American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - Air Conditioning and Refrigeration Institute (ARI)
    - 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)
    - Underwriter's Laboratories (UL)

- National Electrical Manufacturer's Association (NEMA)
- National Fire Protection Association (NFPA)
- American Standards Association (ASA)
- American Welding Society (AWS)
- Canadian General Standards Board (CGSB)
- Canadian Standards Association (CSA)
- Manufacturers Standardization Society (MSS)
- European Standards EN253, 1434, 448, 488, & 489.

As well as UBC Sustainability Development Policy # 5:

[\(https://universitycounsel.ubc.ca/board-of-governors-policies-procedures-rules-and-guidelines/policies/\)](https://universitycounsel.ubc.ca/board-of-governors-policies-procedures-rules-and-guidelines/policies/).

## .2 ETS Codes and Standards

.1 The design, fabrication and installation of the energy transfer stations shall be in accordance with the laws and regulations of the Province of British Columbia. All primary side ETSs must be designed and registered with Technical Safety BC. Stress analysis should be performed at 120°C for both supply and return piping.

.2 In addition, the energy transfer stations shall be designed and installed in accordance with the latest editions of the applicable Codes and Standards from the following authorities:

- ASHRAE Standard 90.1 - Energy Standards for Buildings
- British Columbia Building Code
- CSA B51 –Boiler, Pressure Vessel, and Pressure Piping Code.
- CSA C22.1-2002 – Canadian Electrical Code, British Columbia Electrical Safety Code and Bulletins, and regulations of the local inspection authority.
- Safety Standards for Electrical Equipment, Canadian Electrical Code, Part II.
- The Environmental Protection and Enhancement Act enforced by British Columbia Environment.
- ANSI/ASME B31.1 Power Piping Code and piping system to be registered with Provincial Boiler Safety Authority.
- ANSI/ASME Boiler and Pressure Vessel Code, Section VIII.
- American Society of Testing and Materials (ASTM)
- Underwriter's Laboratories (UL)
- Canadian General Standards Board (CGSB)
- Canadian Standards Association (CSA)
- Manufacturers Standardization Society (MSS)
- Technical Safety BC

As well as UBC Sustainability Development Policy # 5:

[\(https://universitycounsel.ubc.ca/board-of-governors-policies-procedures-rules-and-guidelines/policies/\)](https://universitycounsel.ubc.ca/board-of-governors-policies-procedures-rules-and-guidelines/policies/)

## 2.3 District hot water energy Distribution Service Connections

.1 The first step to install any new or substantially modified connections to the district hot water energy distribution system at UBC is complete a Utility Service Connection Application. This and other forms can be found at <https://energy.ubc.ca/community-services/contractors-developers/>.

.2 Any new connections to the district hot water energy distribution system will be reviewed for consistency with UBC Energy & Water Services standards as defined in the UBC Technical Guidelines.

.3 The Designer shall obtain the District hot water energy service records by contacting the Records Clerk at Infrastructure Development, Records Section (Telephone: 604-822-9570) and develop proposed service connection location(s).

### 3.0 **DISTRICT HOT WATER ENERGY DISTRIBUTION DESIGN OVERVIEW AND CONCEPTS**

#### 3.1 Design Requirements for DPS

##### .1 **Pipe Velocities**

<b>Buried Mains &amp; Mains in Tunnels</b>	2 – 3.5 m/sec
<b>Max. Water Velocity in Service Lines</b>	2 m/sec

##### .2 **Temperatures**

<b>System Rated Supply Temp.</b>	120°C
<b>System Operating Supply Temp.</b>	70°C
<b>Max. Return Temp.</b>	75°C
<b>Min. Return Temp.</b>	35°C
<b>System Operating delta-T</b>	30°C

##### .3 **Pressures**

<b>System Design Pressure</b>	1,600 kPa
<b>System Operating Pressure</b>	1,450 kPa
<b>System Test Pressure</b>	1.5 x Design Pressure

##### .4 **Buried Piping**

<b>Normal Depth of Bury</b>	900-1200 mm
<b>Minimum Depth of Bury</b>	600 mm
<b>Minimum Trench Slope for Drainage</b>	0.50%

.5 The design conditions listed below are general in nature and are to be used for preliminary line sizing. Major extensions or additions to the system should be sized based on a detailed system hydraulic model.

##### .6 **TSBC Registration**

.1 All aspects of the DPS shall be designed and registered with TSBC.

##### .7 **Thermal Expansion & Pipe Stress**

.1 The recommended method to design for pipe stress resulting from thermal expansion is through the use of compensators, expansion pipe sold by Logstor ,expansion bends and U- loops.

##### .8 **Seismic Considerations**

.1 The piping design will incorporate the requirements of TSBC to meet the seismic loading outlined in the latest version of the BC Building Code.

##### .9 **Water Hammer**

.1 For larger systems or systems with pipe velocities exceeding 3.5 m/s, design consideration should be given for water hammer. The piping design will consider the necessity of water hammer control.

##### .10 **Hydro Test and Flushing**

.1 Design consideration should be given for every DPS section Flushing and Hydro Testing before it is connected to existing Close Loop. It should be either reflected in DPS drawings or written instructions to the Contractor.

##### .11 **DPS Zoning**

.1 DPS shall be designed and constructed with adequate amount of Zone Isolation Valves. This is to minimize the negative impact of heat loss in case of necessity to isolate DPS section for upgrade or repair.

- .12 **DPS Vents and Drains**
  - .1 The piping design should incorporate air vent valves at every highest point of DPS to avoid air pockets. *All buried high point vents and drains to be a pre-insulated branch tee with service valve and valve to be a forged valve. Boehmer or equivalent. The vent to be a min size of 38mm.* Consideration should be given to provide means of draining for every DPS Zone. Drain valves at the end of Service Lines may serve the purpose and should not be missed.
- .13 **DPS Leak Detection System (LDS)**
  - .1 DPS LDS should comply with **EN 14419** of latest edition:
    - .1 Design Engineer (DE) should provide a detailed wiring diagram of LDS to contractor and EWS before DPS assembly takes place. Specification of measuring wires assembly instructions, should accompany the wiring diagram.
    - .2 Specification of LDS assembly check with description of equipment required to be provided by DE. DE also to provide guidelines for LDS functional test procedure, description of equipment required for above test, specification of a fault simulation test and data for acceptable test values.

### 3.2 Design Parameters for ETS

- .1 **Piping Sizing Criteria<sup>1</sup>**
  - .1 Pressure Gradient Used to Determine Max. Water Velocity in Service Lines: Based on 250 Pa/m Pressure Gradient.

- .2 **Pressures**

<b>ETS Primary Side Operating ΔP</b>	150 – 550 kPa
<b>Customer Side Design Pressure</b>	≤1,600 kPa
<b>Customer Side Operating Delta P</b>	As required
<b>System Test Pressures</b>	1.5 x Design Pressure

- .3 **Temperatures**

		<i>DES Rated Conditions</i>	<i>ETS Selection Criteria</i>
<b>District Heating Side</b>	Supply Temp <sup>2</sup> .	120°C	70°C
	Return Temp.	<55°C	<40°C

- .1 *ETS HX's shall be selected at 70°C EWT from the DES, but be rated to 120°C. See section 4.1.4 for more details.*
- .4 Low Temperature buildings are preferred to maximize the ΔT and improve system performance (*see UBC Technical Guidelines Section 23 05 00 2.1.1*).
- .5 The design conditions listed above are general but conform to industry standard and will be used for preliminary line and equipment sizing.

<sup>1</sup> Indicated criteria are recommended in accordance with ASHRAE pipe design flow ranges.

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

### 3.3 Hot Water General

- .1 Optimization of the hot water distribution system delta T ( $\Delta T$ ) is critical to the successful operation of the DH system. Therefore, the customer's  $\Delta T$  must be monitored and controlled. In order to optimize the DH system  $\Delta T$  and to meet the customer's hot water demand, the hot water flow rate from the DH plant will vary. Varying the flow rate to satisfy demands saves pump energy for the DH system.
- .2 New buildings' HVAC systems shall employ variable flow hot water heating systems to heating coils which forms an integral part of the HVAC systems by means of two-way modulating valves or three-way mixing valves only (diverting three-way valves lower the delta T and therefore are not recommended). The aforementioned design strategy is strongly recommended as it will save energy costs for *UBC*.
- .3 The energy calculations shall be performed via the energy meter based on input from the flow meter and two temperature sensors.

### 3.4 Pressures

- .1 The DH primary system is designed for a maximum allowable working pressure of 1,600 kPa. Equipment (valves, fittings, etc.) installed for the ETS locations will, where applicable, be selected to minimum ANSI Class 150. The  $\Delta P$  at each service connection will vary depending on its location in the distribution system.
- .2 The Design Engineer shall request the estimated available distribution pressures for each ETS connection from the Owner's Engineer. These pressures typically include an estimate for 10 metres of interconnecting piping downstream of the main isolation valves at the building penetration. A minimum of 150 kPa will be allocated for the critical customer, which includes the ETS equipment and interconnecting piping. Customers closer to the heating 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.

#### .1 Static Pressure

- .1 The DES system has to be sufficiently pressurized at the plant to overcome the elevation difference in the system and to avoid boiling (or flashing) from occurring at the high points. In addition, some further margin is required to minimize the effect of operating disturbances, such as cavitation and pressure surges (i.e. transient pressures). Higher static pressure requirements will limit the maximum allowable dynamic pressure in the system set by the design pressure of 1,600 kPa. This again could put unnecessary limitations on the system capacity.
- .2 Thus, it is generally recommended to install ETSs at the basement or ground floor level to ensure that the building elevations do not put unwanted static pressure limitations on the system.



4.0 **MAJOR EQUIPMENT DESCRIPTION**

The ETS includes equipment the necessary pipes, heat exchangers and associated controls and energy meters. This equipment should be located inside the customer building mechanical room **in the basement**. See Figure 1 and Figure 2 below as an example of a typical ETS located at an exterior wall near the DPS mains in the street.

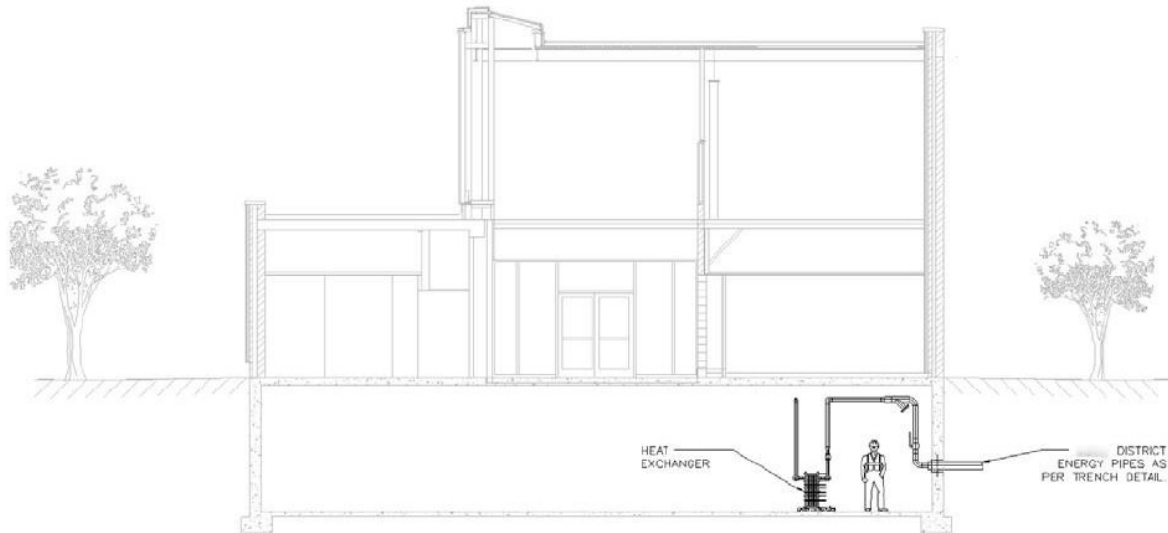


FIGURE 1 TYPICAL ETS INSTALLATION IN BUILDING BASEMENT

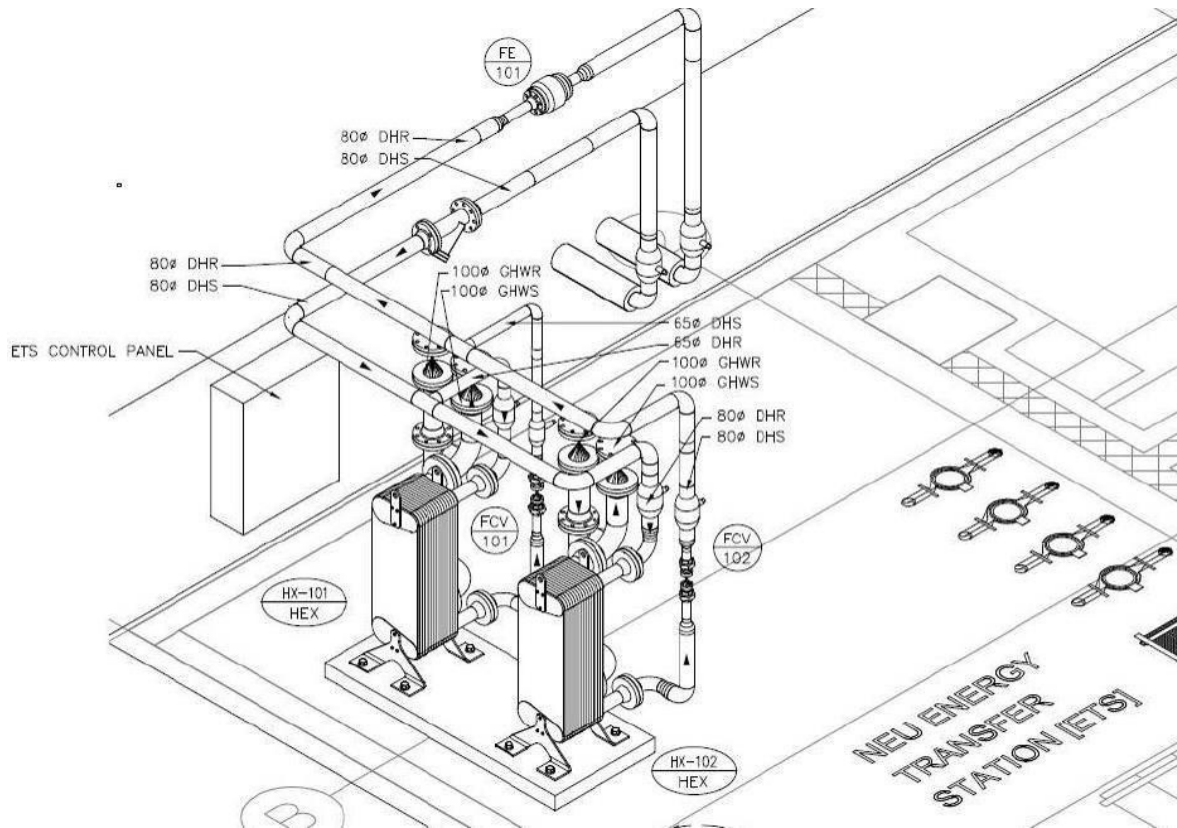


FIGURE 2 TYPICAL ETS (DETAIL)

#### 4.1 Heat Exchangers

- .1 Heat exchangers will be used on connections to all buildings to separate the existing building heating system from the DES (i.e. indirect connection). The optimum selection of each HX will be analyzed on the basis of:
  - .1 Sizing each unit's capacity to match the load and load turn-down as close as possible.
  - .2 Critical nature of the load/operation.
  - .3 Temperature and pressure conditions.
  - .4 Available space in mechanical room.
  - .5 Allowable  $\Delta P$  on both sides of HX.
- .2 Brazed Plate heat exchangers for space heating, and double-wall brazed plate or double walled plate and frame with end plate leak detection for domestic hot water are required for this application. Shell & tube heat exchangers should not be used. *Also see Division 20, Section 20 00 05 Mechanical General Requirements, 2.3.3.*
- .3 **New buildings with coincidental heating and domestic hot water requirements (i.e. Student residences) shall utilize a cascaded design.**
- .4 The following table summarizes the selection criteria:

.1 **Space Heating Heat Exchanger Selection Criteria New Buildings<sup>4</sup>**

Hot Side Conditions			Cold Side Conditions		
Inlet Temp	Outlet Temp	Max. $\Delta P$	Inlet Temp	Outlet Temp	Max. $\Delta P$
70°C	40°C	50 kPa	35°C	46°C	35 kPa <sup>4</sup>

- .2 Each HX will be sized for a maximum 5°C approach on the hot side (DH side) outlet to cold side inlet. Higher customer return temperatures and  $\Delta T$ s will have an adverse impact to the overall system operation and performance.

.3 **Domestic Hot Water Heat Exchanger Selection Criteria**

Hot Side Conditions			Cold Side Conditions		
Inlet Temp	Outlet Temp	Max. $\Delta P$	Inlet Temp	Outlet Temp	Max. $\Delta P$
70°C	35°C	50 kPa	5°C	60°C	50 kPa

.4 **Cascaded Domestic Hot Water Pre-Heat Exchanger Selection Criteria**

Hot Side Conditions			Cold Side Conditions		
Inlet Temp	Outlet Temp	Max. $\Delta P$	Inlet Temp	Outlet Temp	Max. $\Delta P$
70°C	35°C	50 kPa	5°C	55°C	50 kPa

- .5 Note: The Cascaded DHW Pre-heat exchanger is to be sized for the full flow from both Hot water and DHW heat exchangers with a maximum  $\Delta P$  of 50 kPa on the DH side. See standard drawings for further details.

<sup>4</sup> 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 equipment.

- .6 The design pressure on the hot side (DH) of the HX will be 1,600 kPa. On the cold side, the design pressure will be determined by the building hot water system pressure. The maximum cold side pressure will be 1,600 kPa.
- .7 All heat exchangers shall have a Valid CRN for British Columbia with a supplied Manufacturers Data report (MDR).

#### 4.2 Hot Water Control Parameters

- .1 As stated previously, the DH supply temperature may vary between 70°C and 120°C. The supply water temperature is lowered outside the peak conditions for the purpose of conserving energy. The secondary return temperature must be no higher than 50°C for new buildings. The objective of the control system is to provide as cool a supply temperature as possible that will still meet the customer's capacity requirements while maximizing the  $\Delta T$  between the District Heating Supply and Return (DHS&R) distribution piping. The minimum DH supply temperature is limited to 70°C in summer in order to meet the requirements of the domestic hot water systems whose storage tanks must be maintained at minimum 60°C to prevent bacteria growth (i.e. Legionella) in the system.

#### 4.3 Control & Measuring Equipment Performance

- .1 Each ETS will have a control & metering panel responsible for calculating energy consumed at each ETS and maintaining proper temperature relationships between the DH system supply and each building. It is recommended to use two control valves i.e. 1/3 & 2/3 split range for flow rates larger than 5 L/s for larger turn down. Alternatively, a 50/50% split can be used if higher redundancy is desired.

#### 4.4 Energy Meters

- .1 It is critical that high-quality integrated energy meters are used to achieve optimum metering accuracy and performance. Magnetic (preferred) or ultrasonic flow meters are recommended to be used at each building ETS. In addition, the integrated meters comprise of matched pair platinum temperature sensors and a sealed factory programmed integrator (i.e. calculator). These meters meet existing international standards (OIML R75 and EN1434) for thermal energy metering, as well as the Canadian standard (CSA C900). Magnetic (preferred) and ultrasonic flow meters have relatively low pressure drops, good range ability and accuracy while requiring very little maintenance. Also, the minimum straight run requirements are greatly reduced (5 diameters upstream and 3 diameters downstream) as compared to some other types of meters.

#### 4.5 Networking Communications

- .1 The Communication network will provide the communication link between each customer ETS and the plant. This will allow remote monitoring, control of each ETS. Metering will be connected to the Campus wide ION network.
- .2 The Communication network will be routed through UBC's IT network and connected into the campus wide BMS system. Siemens and ESC are preferred vendors.

#### 4.6 DPS Leak Detection System (LDS) EN 14419

- .1 LDS should be assembled as per DE instructions with Logstor components. After finishing of each measuring section, it should be tested for:
  - .1 Continuity of measuring wires
  - .2 No electrical contact or moisture between the wires and pipes

- .2 Upon assembly of LDS zone, the System functional test is to be conducted with fault simulation.
- .3 All data is to be recorded and presented to DE and EWS *complete with as-built drawings with leak detection resistance listed for each joint.*
- .4 After 4 weeks of operation LDS functional test should be repeated by contractor and result to be recorded. Test is to be witnessed by EWS representative.
- .5 Before extending or renovating of existing LDS the actual state of System should be measured and documented:
  - .1 Wiring ohmic resistance from conductor to conductor
  - .2 Isolation resistance from conductor to pipe.

#### **4.7 Differential Pressure sensor**

- .1 An electronic differential pressure sensor will be fitted between the inlet and return on the primary side. It must be capable of being read locally as well as have an output to allow it to be read remotely (network connection). (Endress and Hauser or Rosemount are preferred.)

## 5.0 **MAJOR EQUIPMENT SPECIFICATIONS**

### 5.1 Piping Material

#### .1 Buried District Energy Distribution Piping EN253

SCOPE: This section specifies prefabricated and pre-insulated piping for direct burial installation as a hot water DES. Fluid temperatures are limited to the range 4°C to 120°C.

##### .1 System Function

- .1 The DES shall be installed as a fully welded and bonded system in which the steel carrier pipe, insulation and outer casing are bonded together to form a solid unit. This solid unit when buried is completely sealed from soil and water ingress and hence provides superior longevity and performance. It is critical for owners to find suppliers of complete buried systems rather than applying a significant effort in assembling components from multiple suppliers to provide a completely sealed system. Piping System shall conform to EN253 standards (Logstor or approved equal).
- .2 The system comprises a steel carrier pipe, polyurethane foam insulation with integral copper alarm wires, and an outer casing of high density polyethylene. The system shall be designed such that the expansion movements of the steel carrier pipe are transferred to the outer casing via the foam insulation. The elements of the bonded pipes shall be manufactured to expand and move together. The movements are restricted by the friction between soil and jacket pipe, which acts as the anchorage for the pipe system. Generally external anchors are not required.
- .3 Expansion is allowed for as determined by the stress analysis (see Section 3.9 for methods used to reduce pipe stress due to thermal expansion).

#### .2 District Energy Distribution Piping in Tunnels and in Buildings

SCOPE: This section specifies welded piping that is insulated on site for installation in the existing tunnel system and in buildings. Fluid temperatures are limited to the range of 4°C to 120°C.

##### .1 System Function

- .1 The distribution piping system shall be installed as a fully welded system.

##### .2 Tunnel & Building Pipe Material

- .1 All tunnel and building distribution piping will be designed, constructed, and tested in accordance with ASME B31.1 Power Piping Code. In general, all tunnel and building distribution piping is of welded carbon steel construction (A53 schedule 40 typical and standard weight in the larger pipe dimensions).
- .2 Mechanical groove joint piping systems will not be accepted in this service.
- .3 Piping will be designed, specified, constructed, installed and registered with TSBC.
- .4 The transition from the buried EN253 pipe to standard weight tunnel or building piping will occur after the wall penetration.

##### .3 Tunnel and Building Pipe Leak Detection

- .1 There will be no leak detection system in the tunnel piping portion. Termination of the leak detection system in the buried piping will be determined at the design phase *in consultation with EWS* as well as the best method of communication to the monitoring center.
- .2 The leak detection system terminates upon entry into each building.

## 5.2 Heat Exchangers

### .1 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.
- .2 Plate thickness shall be of a minimum of 0.4mm. The plate pack shall be covered by Type 316 stainless steel cover plates.
- .3 The flanged connections shall be located in the front or rear cover plate. Flanged nozzle connections shall conform to ASA standards, and shall be of the pressure rating design indicated below.
- .4 Heat exchangers shall be *supplied with removable insulation jackets, support stands and brackets. Stainless steel or OEM.*
- .5 The heat exchangers shall be designed for the following continuous operating pressures and temperatures: 1,600 kPa and 120°C, hot water
- .6 Heat exchangers must be mounted according to manufacturer's requirements.
- .7 The heat exchanger characteristics shall be as per the attached schedule.  
Standard of Acceptance: Xylem, Alfa Laval or equivalent

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

- .1 Frame shall be carbon steel with baked epoxy enamel paint. The frame shall be designed without additional welds and reinforcements. The carrying and guide bars shall be bolted to the frame, not welded. The carrying and guide bar surface in contact with the plates and roller shall be made of, or clad with a corrosion resistant material such as stainless steel. The bolts shall be greased with molybdenum grease and protected with plastic sleeves.
- .2 Connections shall be *a flanged connection*. Flanged connections shall conform to ASA standards.
- .3 The double wall plates shall be composed 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.
- .4 Plate thickness shall be of a minimum of 0.4mm.
- .5 *The use of spiral wound gaskets on all primary flanged faces is required.*
- .6 The heat exchangers shall be designed for the following continuous operating pressures and temperatures: 1,600 kPa and 120°C, hot water.
- .7 The heat exchanger capacities shall be as per design specifications. Standard of Acceptance: Xylem or equivalent.

### .3 Double walled Brazed Plate Heat Exchangers - Domestic Hot Water

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.
- .2 Plate thickness shall be of a minimum of 0.4mm. The plate pack shall be covered by Type 316 stainless steel cover plates.

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- .3 The flanged connections shall be located in the front or rear cover plate. Flanged nozzle connections shall conform to ASA standards, and shall be of the pressure rating design indicated below.
  - .4 Heat exchangers shall be supplied with removable insulation kits and supports (stands and, brackets if required etc.). The insulation shall consist of Freon free insulation (polyurethane foam) and ABS plastic cover at a minimum.
  - .5 The heat exchangers shall be designed for the following continuous operating pressures and temperatures: 1,600 kPa and 120°C, hot water
  - .6 Leak detection holes must be visible on the front cover plate of the heat exchanger and must not be covered.
  - .7 Heat exchangers must be mounted according to manufacturer's requirements.
  - .8 The heat exchanger characteristics shall be as per the attached schedule. Standard of Acceptance: Xylem, or equivalent.

### 5.3 Controls & Measuring Equipment

#### .1 Description

- .1 The controls are made up of programmable controllers, temperature sensors, outdoor sensors, control valve stations and other miscellaneous instrumentation. The controls and energy metering systems shall be integrated and compatible with the existing building automation system (BAS) and with a compatible communication protocol to perform the functions described in this section. All devices and equipment shall be approved for installation by the Owner and/or Owner's Engineer.
- .2 All controls shall be BACnet compatible.

#### .2 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.
- .3 Hydrostatic test pressure shall be 1.5 times the design pressure using calibrated pressure gauges.

#### .3 Control Valves

- .1 Control valves are to be sized by control supplier according to design specification herein. Water valves shall be sized on the basis of minimum 50% of available differential pressure or minimum 75 kPa (11 psi) pressure drop. Pressure drop for valves shall be submitted for review, including all CV values.
- .2 Valves shall be equal percentage type, two-way, single-seated, and equipped with characteristic type throttling plug, #316, stainless steel stem and seat. Provide with necessary features to operate in sequence with other valves and adjustable throttling range as required by the sequence of operations.
- .3 Valves shall be able to handle a minimum of 345 kPa (50 psi) differential pressures for modulating service with range ability greater than 100:1. Actuator selection shall be for close-off pressures greater than 690 kPa (100 psi). Arranged to fail-safe as called for tight closing and quiet operating. Leakage shall be less than 0.1% of Cv. **Standard of Acceptance: Siemens or equivalent.**
- .4 All two way controls valves shall be slow closing to prevent water hammer.

#### .4 Electric Actuators

- .1 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.
- .2 Operator shall be synchronous motor driven with minimum 750 Newtons of thrust and force sensor safe.
- .3 Control stroke time shall be less than 30 seconds. Actuator shall include a manual clutch that enables manual positioning of valves during power failures and servicing. Upon restoration of power, actuator will automatically reposition itself without intervention. Actuator shall have self-lubricating bearings to minimize maintenance requirements. Indication of position shall be visible at all times. **Standard of Acceptance: Siemens SKB/SKC/SKD or equivalent.**

#### .5 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. Lonworks) for integration with control panel with remote communication capability.
- .2 *DES meters shall be network connected for remote monitoring only. The Division 20 contractor shall provide all necessary communication equipment to ensure effective remote monitoring is achieved. Refer to standard drawing E4-6c.*
- .3 Energy Calculator shall comply with OIML R75 and EN1434, with accuracy: +/- (0.15+2/Δt) % and water temperature range 1°C – 160°C and 30 seconds flow calculation intervals. The meter shall have a permanent memory (EEPROM). The meter display shall show the following items:
  - Accumulated thermal energy: MWh
  - Accumulated water flow: m<sup>3</sup>
  - Actual thermal power: kW
  - Actual water flow: l/h or m<sup>3</sup>/hr
  - Supply temperature: °C
  - Return temperature: °C
  - Temperature differential: °C
  - Peak thermal power: kW P
  - Peak water flow: l/h or m<sup>3</sup>/hr P
  - Hour Counter: HRS
- .4 The meter shall be factory calibrated and supplied with verification certificate. **Standard of Acceptance: Endress & Hauser (magnetic) and Kamstrup Ultrasonic or equivalent.**
- .5 The flow meter shall be magnetic or ultrasonic in compliance with OIML R75 and **EN1434**, with accuracy +/- 1.0% of rate within flow range of 0.3 to 9 m/s and minimum rangeability 1:30. Fluid temperature range shall be 4 to 120°C and fluid pressure range full vacuum to 1,600 kPa. Factory calibrated **Standard of Acceptance: Endress & Hauser (magnetic) and Kamstrup Ultrasonic or equivalent.**
- .6 The meter shall be factory calibrated and supplied with calibration certificate. **Standard of Acceptance: Endress & Hauser (magnetic) and Kamstrup Ultrasonic or equivalent.**
- .7 Resistance Temperature Detectors (RTDs) shall be 4-wire PT500 Pocket Sensor



(Paired) with connecting head performance  $.04^{\circ}\text{C } \Delta t$  deviation (pairing). **Standard of Acceptance: Endress & Hauser (magnetic) and Kamstrup Ultrasonic or equivalent.**

**.8 Sequence of Operations**

**.1 General**

.1 The general control strategy to be implemented for the new Energy Transfer Stations shall be the supply temperature reset based on the outside air temperature. In addition, a reset function based on return temperature shall be employed 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.

.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 Domestic Hot Water (DHW)**

.1 The controller shall be programmed to fully close the DHW control valve when the recirculation pumps on the secondary side shut off. When the recirculation pumps are turned back on, the controller will be programmed with a 20 second delay, prior to opening the DHW control valve.

.2 During normal operation, the customer domestic hot water supply temperature shall fix set point, initially at  $60^{\circ}\text{C}$  (adjustable range 40 to  $65^{\circ}\text{C}$ .) The controls shall have a Maximum limit (adjustable, initially set at  $65^{\circ}\text{C}$ ) when the control valve will go to closed position.

**.4 Alarms**

.1 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.

**.6 Leak Detection System Equipment**

.1 LDS equipment should be Logstor approved. Ordinary electrical wire or any other kind of unauthorized wire is not allowed to form any part of the LDS assembly.

**5.4 Valves – Primary Side Isolation Valves**

**.1 Design**

- .1 Valve construction design and tested to EN488 specification
- .2 Valve design to be fully welded
- .3 Design to be suitable for above and below ground service
- .4 For service in district heating, valve shall be suitable for 120 degrees C and 232 psi pressure
- .5 Minimum rating PN25 to allow for testing at 1.5 times for system expansion.
- .6 Full or reduced bore
- .7 Weld ends to schedule 40 for above ground and EN253 for buried service
- .8 If flanged ends are required, flanges to be to ANSI
- .9 Above ground valves should have a 60 mm extension to allow for insulation
- .10 Provide top of stem position indication with a visible groove
- .11 Operator – Lever operated up to 6", gearbox for 8" and up

**.2 Materials**

- .1 Body, only forged materials are accepted, ASTM A106 or A352LF2
- .2 cold pressed steel is not acceptable
- .3 Ball, stainless steel
- .4 Seat PTFE with minimum 25% glass reinforced
- .5 Seat to be spring supported, individual coil springs are preferred
- .6 Stem, stainless steel
- .7 O-rings, EPDM

**.3 Buried service**

- .1 Valves for buried service to be pre-insulated with polyurethane foam and PE outer protection as per EN253
- .2 Pre-insulation to have leak detection wiring
- .3 Valve should have an integral welded extension to an agreed height
- .4 A minimum of 2 O-rings at the bottom and 2 O-rings at the top of the stem are required to prevent water ingress into the stem assembly
- .5 The assembly should provide an internal mechanical travel stop in the stem extension
- .6 A parallel square nut is to be provided
- .7 Gear operator required for valves size 8" and up (portable)

**.4 Valve testing**

- .1 All valves to be Hydro shell tested at 1.5 times the rated pressure
- .2 All valves to be seat tested; both seats to be tested at max. 1.1 times the rated pressure
- .3. Acceptable leakage rates for seat tests are to API 598 or rate A of EN12266

**5.5 Gaskets**

- .1 The use of flexitalic gaskets on all primary flanged faces is required.

## 6.0 DISTRICT HEATING PRIMARY PIPING

### 6.1 References

- .1 ANSI/ASME B1.20.1-1983 (R2001), *Pipe Threads, General Purpose*.
- .2 ANSI/ASME B31.1- [2004], *Power Piping*.
- .3 ANSI/MSS SP-58-[2002], *Pipe Hangers and Supports – Materials, Design, and Manufacture*.
- .4 ASME B16.34-1996 - *Valves - Flanged, Threaded, and Welding End*
- .5 ASME B31.5 – 2001, *Refrigeration Piping and Heat Transfer Components*.
- .6 ASTM A47/A47M-99(2004), *Ferritic Malleable Iron Castings*.
- .7 ASTM A53/A53M-05, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*.
- .8 ASTM A105/A105M-05, *Carbon Steel Forgings for Piping Applications*.
- .9 ASTM A106/A106M-04b, *Seamless Carbon Steel Pipe for High Temperature Service*.
- .10 ASTM A108-03, *Steel Bar, Carbon & Alloy, Cold-Finished*.
- .11 ASTM A126-04, *Gray iron Castings for Valves, Flanges, and Pipe Fittings*.
- .12 ASTM A181/A181M-01, *Carbon Steel Forgings for General-Purpose Piping*.
- .13 ASTM A193/A193M-05, *Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service*.
- .14 ASTM A194/A194M-05b, *Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High Temperature Service, or both*.
- .15 ASTM A216/A216M-04, *Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service*.
- .16 ASTM A234/A234M-05a, *Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*.
- .17 ASTM A278/A278M-01, *Gray Iron Castings for Pressure-Containing Parts for Temperatures Up To 650°F (350°C)*.
- .18 ASTM A307-04, *Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength*.
- .19 CAN/CGSB-14.5-[M88], *Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type*.
- .20 CSA B51 - 03 *Boiler, Pressure Vessel, and Pressure Piping Code*.
- .21 MSS SP-67-2002a, *Butterfly Valves*.
- .22 MSS SP-70-1998, *Cast Iron Gate Valves, Flanged and Threaded Ends*.
- .23 MSS SP-71-1997, *Grey Iron Swing Check Valves, Flanged and Threaded ends*
- .24 MSS SP-72-1999, *Ball Valves with Flanged or Butt-Welding Ends for General Service*.
- .25 MSS SP-80-2003, *Bronze Gate, Globe, Angle and Check Valves*.
- .26 MSS SP-85-2002, *Cast-Iron Globe and Angle Valves Flanged and Threaded Ends*.
- .27 MSS SP-58-[2002], *Pipe Hangers and Supports – Materials, Design, and Manufacture*.
- .28 EN253 *Pre-insulated Bonded Piping Systems (European Standard)*
- .29 EN448 *Pre-insulated Fitting Assemblies (European Standard)*
- .30 EN488 *Pre-insulated Steel Valve Assemblies (European Standard)*
- .31 EN489 *Joint Assemblies on Pre-insulated Pipes (European Standard)*
- .32 DIN 1626, *Steel Quality St 37.0 (ASME-A53 Grade B Equal)*
- .33 ISO4200/DIN2458 – *Plain End Steel Tubes, Welded and Seamless - Measurements and weights*
- .34 ANSI/ASME B31.1 – (Latest), *Power Piping*.
- .35 ANSI/ASME B31.9 – (Latest), *Building Services Piping*.
- .36 ANSI/ASME Boiler and Pressure Vessel Code-(Latest):
- .37 *Section 1: Power Boilers*.
- .38 *Section V: Nondestructive Examination*.
- .39 *Section IX: Welding and Brazing Qualifications*.
- .40 CSA W48-01, *Filler Metals and Allied Materials for Metal Arc Welding*.
- .41 CSA B51-03, *Boiler, Pressure Vessel and Pressure Piping Code*.
- .42 CAN/CSA-W117.2-01, *Safety in Welding, Cutting and Allied Processes*.

- .43 *CSA W178.1-02, Certification of Welding Inspection Organizations.*
- .44 *CSA W178.2-01, Certification of Welding Inspectors.*
- .45 *CGSB 48.2-92, Spot Radiography of Welded Butt Joints in Ferrous Materials.*
- .46 *AWS B2.1:2005, Welding Procedure and Performance Qualification.*
- .47 *AWS C1.1M/C1.1-2000, Recommended Practices for Resistance Welding.*
- .48 *AWS W1:2000, Welding Inspection.*
- .49 *ANSI/AWWA C206-03, Field Welding of Steel Water Pipe.*
- .50 *CSA W59-03 Welded Steel Construction.*

## 6.2 Pipe Welding

- .1 District heating (primary) side shall be an all-welded piping system in accordance with ANSI B.31.1 and CSA B51. The building (secondary) side piping shall be a welded system in accordance with ANSI B.31.9. If grooved piping is used in the existing building secondary systems, it can be used as an acceptable alternate. However, it is strongly recommended that all risers be welded for maximum system integrity.
- .2 Welding qualifications to be in accordance with CSA B51 *or* ASME B31.1 *section 127.5*.
- .3 Qualified and licensed welders shall possess a certificate for each procedure to be performed by the authority having jurisdiction.
- .4 Registration of welding procedures shall be in accordance with CSA B51 *or* ASME B31.1 *Section 127.5*.
- .5 *Submit welder's qualifications to Owner's Representative.*
- .6 *Joint Fit-up*
  - .1 *Valves welded into the system shall be open as the welding is carried out.*
  - .2 *The geometry of pipe weld joints (i.e. joint preparation and root opening) shall be in accordance with the tolerance specified by the weld joint sketches contained in the welding procedures submitted to the Owner's representative.*
  - .3 *In cases where the internal misalignment exceeds 1/16", the component with the wall extending internally shall be trimmed so that the adjoining internal surfaces are approximately flush. This trimming must not result in a piping component wall thickness less than the minimum design thickness. The change in contour shall not exceed 30 degrees*
- .7 *Transition, Different outside diameters*
  - .1 *When pipes of different outside diameters are to be welded together, either of the following two procedures shall be followed:*
    - .1 *Taper the outside diameter of the larger pipe by grinding or machining before welding to the outside diameter of the smaller pipe. The taper angle must not exceed 30°.*
    - .2 *Fill the weld joint with weld metal, flush with the outside surface of the pipe having the larger diameter. The weld metal transition between the larger and smaller pipe shall have a slope not exceeding 1:3, which may be obtained by grinding. \**

## 6.3 Valves

- .1 Install isolating valves at all branch take-offs, at each piece of equipment and elsewhere as indicated. All primary isolation valves to be welded. Welding to valves must be done in accordance with the manufacturers' recommendations in order to prevent body distortion and to maintain tight shutoff characteristics of the valve.
- .2 *Isolation Ball Valves:*
  - .1 *NPS 2" to 8": Working Pressure 1.6 MPa (232 psig) at 120°C , Sch. 40 Butt Weld ends to match pipe, steel body, stainless steel ball and stem, Teflon seat, reduced bore, class 300 lever actuator for valves NPS ≤6" within 2.44m (8 ft.) of floor. Provide gear operated actuator with handwheel for valves NPS ≥8" and chain wheel above 2.44m. Acceptable materials: Arinah Services – Broen Ballomax, Meridian Valves – Vexve, Armour Valve – Bohmer.*

- .3 *Drain and Air Vent valves:*
  - .1 *NPS ½" to 2": Threaded, 2000 psig WOG, ball valve, cold non-shock, 150 psig saturated steam steel body, RTFE seats and seals, blow-out proof steam design, lever handle, Acceptable material: Apollo 72-100, NIBCO T-590-CS-R-66.*
- .4 *Strainers:*
  - .1 *Install strainers at both secondary and primary side heat exchangers inlets in locations to allow easy access for removal of screen.*
    - .1 *NPS ≤2": Cast steel, Y-pattern, shall be flanged with stainless steel 5/32" perforated screen with 30 mesh (0.5mm), Class 300 for 1.6 Mpa (232 psig) and 120°C. Acceptable Materials: Spirax Sarco, SSI Equipment Inc*
    - .2 *NPS ≥2½": Cast Steel body flanged Y-pattern, stainless steel 5/32" perforated screen with 30 mesh (0.5 mm). Screen area shall be minimum three times area of inlet pipe. Class 300 for 1.6 MPa (232 psig) and 120°C. Acceptable Materials: Spirax Sarco, SSI Equipment Inc.*
  - .2 *Provide drain ball valve and piping to a point 400 mm from the floor. The pipe end shall be provided with a threaded forged steel cap.*
  - .3 *Outlets for branch connections:*
    - .1 *Full Size; Standard Weight, Welded tee*
    - .2 *One size smaller: Standard Weight, welded reducing tee, or saddle welds.*
    - .3 *Two or more sizes smaller;*
      - .1 *NPS ≤2" – Thread-o-let or reducing tee.*
      - .2 *NPS ≥2½" – Weld-o-let or reducing tee.*

#### 6.4 Gauges

- .1 *Thermometers:*
  - .1 *Industrial, Bi-metal Dial, 100 -125 mm size, adjustable angle, aluminum case, 13 mm NPT stainless steel separate well, front recalibrator.*
  - .2 *Unit: Dual Scale °C/°F scale*
  - .3 *Accuracy: within ±0.5 degrees of reading.*
  - .4 *Range: Applicable range & span will be selected according to process conditions.*
  - .5 *Maximum 2 deg. per division.*
  - .6 *Acceptable materials: Winters, Wika, Weiss*
- .2 *Pressure Gauges:*
  - .1 *Dial type, 110 mm diameter, 304 stainless steel case and ring, phosphor bronze tube, brass or stainless-steel movement, glass or acrylic window. 13mm NPT process connection.*
  - .2 *Liquid filled*
  - .3 *Unit: Dual scale kPa/PSI*
  - .4 *Accuracy: within 1.0% of full scale.*
  - .5 *Range: 1.5 times the process system operating pressure.*
  - .6 *Accessories: N/A*
  - .7 *Acceptable materials: Winters, Wika, Weiss*
- .3 *Interior Piping:*
  - .1 *Piping*
    - .1 *To ASTM A53 Grade B.*
    - .2 *NPS ≤1 ½": Sch. 80, ERW or seamless, plain ends.*
    - .3 *NPS 1 ½" and over: Standard Weight, ERW or Seamless, beveled ends,*
  - .2 *Fittings:*
    - .1 *NPS ≤1 ½": Class 3000, forged steel screwed ends and socket weld ends, to ASTM A181.*
    - .2 *NPS ≥2": Standard Weight, forged steel, bevel ends, to A234, Grade WPB..*
  - .3 *Coupling, caps, plugs:*
    - .1 *NPS ½" to 2": Class 2000, screwed ends or socket weld ends, to ASTM A181.*

- .4 *Nipples for drains, vents, pressure gauges:*
  - .1 *NPS ½" to 2" : Sch. 80, screwed, to ASTM A53, Grade B.*
- .5 *Unions:*
  - .1 *NPS ≤2": Class 3000, socket welded ends, forged steel, steel-to-steel ground joint, to ASTM A181.*
- .6 *Flanges:*
  - .1 *NPS ≤2": Class 150 / 300, raised face, socket welded ends, to ASTM A105 and ANSI B16.5.*
  - .2 *NPS ≥2½": Class 150 / 300, raised face, weld neck (bored to suit pipe) to ASTM A105 and ANSI B16.5.*
  - .3 *Flange to match class and rating of flange supplied with equipment*
- .7 *Bolts and nuts (low strength):*
  - .1 *NPS ≤2": bolts, carbon steel, semi-finished with heavy hex nuts, to ASTM A307, Grade B.*
  - .2 *NPS ≥2½": Stud bolts, carbon steel, semi-finished with heavy hex nuts, to ASTM A307, Grade B.*

## 7.0 Inspection and Testing

### .1 General

- .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2, CGSB 48-GP-2M, and approved by Design Engineer. To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .2 The Design Engineer shall review and approve the contractor's pressure testing procedures at least 72 hours prior to carrying out any testing.

### .2 Inspections

- .1 Unless otherwise approved by the Design Engineer, all joints in the piping systems shall remain uncovered until all tests are completed and the systems have been inspected and approved by the Engineer or Inspector.
- .2 DPS Leak Detection System assembly checks should be carried out continuously during the construction work.

### .3 Hydrostatic Testing

- .1 Hydrostatic testing shall be performed in accordance with the requirements of ANSI B31.1., Owner's specifications, and the contractor's Inspection and Test Plan. Test pressure shall be 1.5 times the system design pressure.
- .2 Hydro test water shall be clean, filtered fresh or city water. There shall be no leakage in the pipeline.
- .3 All District Heating primary piping shall be hydraulically tested after installation and before painting, insulating, and concealing in any way, at a minimum test pressure of 2400 kPa for 4 hours without a drop in pressure. The secondary heating shall be hydraulically tested at 1.5 times design pressure or a minimum of 690 kPa (100 psi) as per ANSI B31.9.

- .4 Any equipment not capable of withstanding the designated test pressure shall be isolated. Flow meters, heat exchangers, and control valves are to be removed and spool pieces installed before commencing pressure tests.
- .5 The Design Engineer shall make the contractor responsible for obtaining all approvals from jurisdictional bodies for the carrying out of pressure tests on piping with joints not exposed for visual examination.

#### .4 Radiographic Testing

- .1 20% of all primary welds shall be radiograph tested. If any welds are shown to fail a second test will be required with radiograph of 100% of welds.

### 8.0 Cleaning and Flushing

- .1 The Design Engineer shall review and approve the contractor's flushing procedure.
- .2 Primary piping shall be flushed, with a chemical flush and then with potable water, to remove all foreign material from the inside of all piping to the Design Engineer's approval. Flushing velocity shall be a minimum of 1.5 m/s.
- .3 Typical acceptable system water concentrations:
  - Iron levels should be below 2 ppm.
  - Hardness should be below 2 ppm.
  - Chloride levels should be maximum 250 ppm if 316 SS Heat Exchanger plate material is used or 50 ppm for 304 SS.
  - pH level of 9.5-10
- .4 Water is to be tested by a water treatment analyst during the cleaning and flushing procedure.
- .5 The Contractor shall take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation. Flow meters, heat exchangers, and control valves are to be replaced with spool pieces.
- .6 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.

### 9.0 Commissioning

- .1 Prior to the commissioning of the DH system, both primary and secondary sides must be flushed and cleaned to the satisfaction of the Owner. The strainers shall be cleaned. Heat exchangers will only be allowed to be commissioned pending verification of the proper strainer screen and mesh have been installed at the inlets to the heat exchanger (s). The proper strainer screen/mesh sizes are as per the following:
  - .1 Braze Plate heat exchangers: 1/8" stainless steel perforated screen with 0.5mm (30) mesh.
  - .2 Plate heat exchangers: 3/64" stainless steel perforated screen.
- .2 After satisfactory water quality analysis by a qualified water treatment contractor, system start-up and commissioning may commence. A certification from the water treatment contractor will verify that the water quality is acceptable.

### 10.0 Accessibility

- .1 All equipment, strainers, control valves, heat exchangers, energy meters and sensors shall be installed *with Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated by Owner's representative.*
- .2 *Provide unions or flanges for ease of maintenance. Install as required. All equipment, and control valves to be provided with union or flanges for easy removal and replacement.*

### 11.0 DES Piping Installation

- .1 The district Energy System (primary) side shall be an all-welded piping system in accordance with ANSI B.31.1 and CSA B51

### 12.0 Pipe Welding

- .1 Welding qualifications to be in accordance with CSA B51 and ANSI/ASME B31.1. Qualified and licensed welders shall possess a certificate for each procedure to be performed from the authority having jurisdiction.
- .2 Registration of welding procedures shall be in accordance with CSA B51 and ANSI/ASME B31.1.

### 13.0 Valves

- .1 Install isolating valves at all branch take-offs, and elsewhere as indicated. All primary isolation valves to be welded. Welding to valves must be done in accordance with the manufacturers' recommendations in order to prevent body distortion and to maintain tight shutoff characteristics of the valve. Valve specifications can be found under major equipment specifications.

### 14.0 Inspection and Testing

- .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2, CGSB 48-GP-2M, and approved by Design Engineer. To ANSI/ASME Boiler and Pressure Vessel Code Section V: *Non destructive Examination. Inspections to be performed by a Third Party testing agency.*
- .2 The Design Engineer shall review and approve the contractor's pressure testing procedures at least 72 hours prior to carrying out any testing. Unless otherwise approved by the Campus Chief Engineer or TSBC Inspector, all joints in the piping systems shall remain uncovered until all tests are completed and the systems have been inspected and approved by the Campus Chief Engineer or TSBC Inspector.
- .2 DPS Leak Detection System assembly checks should be carried out continuously during the construction work.

### 15.0 Burying of DES Pipe prior to Pressure test (special Circumstances)

- .1 The contractor may cover (by insulating and / or burying) Central or District hot water heating piping prior to the final pressure test, provided that all of the following conditions are complied with:
  - .1 Pressure piping shall be within the scope of, and constructed to ASME B31.1 Power Piping. In addition the pressure piping shall be limited to Central or District heating piping systems only, limited to Hot Water service only where the design pressure does not exceed 1600 kPa (232 psig) and the design temperature does not exceed 120 degrees Celsius (248 degrees Fahrenheit and limited to the hydrostatic method of pressure testing only.
  - .2 Contractor shall submit and obtain registration of the piping design from Technical Safety BC prior to construction.
  - .3 specification shall include the details of how the piping shall be buried.
  - .4 The contractor shall submit and obtain acceptance of a documented pressure test procedure from Technical Safety BC, prior to conducting the pressure test. The procedure shall meet the requirements of ASME B31.1, and shall include an extended holding time for the test and include the method(s) to detect a leak.
  - .5 The Contractor shall also provide a documented procedure for the method to uncover and locate any leak that may occur during the hydrostatic testing of insulated and / or buried piping.
  - .6 Insulated and/ or buried pressure piping that shows any evidence of leakage during the pressure test shall be uncovered to the extent required to locate the leaking



- area and to effect repairs. The repairs shall meet the requirements of ASME B31.1. The repaired area shall be subject to a pressure test following completion of the repair.
- .7 Unlisted materials shall not be utilized for construction of the pressure piping unless all of the requirements of ASME B31.1 para 123.1.2 are fully complied with, prior to fabrication of the pressure piping.
  - .8 The piping to be pressure tested shall be verified by the Owner's Inspector to be constructed in compliance with BC Regulation 104 / 2004, CSA B51 Boiler, Pressure Vessel and Pressure Piping Code, ASME 831.1 Power Piping Code, the owners specification, and the registered design prior to the pressure test.
  - .9 Upon completion of a successful pressure test, a Construction Data Report for Piping Systems Constructed Inside British Columbia (form 1329) shall be completed and executed as follows:
    - .1 Signed and dated under the Certificate of Compliance by a licensed Contractor, and
    - .2 Signed and dated under Certificate of Inspection section by the Owners Representative and by a Safety Officer employed by TSBC , subsequent to a successful completion of the hydrostatic pressure test
    - .3 A copy of the report shall be submitted to Technical Safety BC
  - .2 The Contractor shall document the criteria that must be met prior to covering the pressure piping by any means (including by insulation and / or burying). The criteria shall include but not limited to:
    - .1 The Contractor shall provide free access to the designated Owners Inspectors and to a Safety Officer to perform any inspections deemed necessary, prior to covering the pressure piping.
    - .2 The Contractor shall notify and obtain prior acceptance of a Safety Officer prior to covering the piping.
    - .3 iii. The piping shall be constructed in compliance with the design, material, fabrication, assembly, examination and testing requirements of the ASME 831.1, and shall be constructed in accordance with the design that has been registered with TSBC.
    - .4 All fabrication, assembly, erection activities and non-destructive examinations required by ASME B31.1 Table 136.4 (including visual weld inspection), and any required repairs, shall be completed prior to the final pressure test
    - .5 A Safety Officer may request any pressure piping be uncovered, at any time and the contractor shall comply with such a request.

## 16.0 Hydrostatic Testing

- .1 Hydrostatic testing shall be performed in accordance with the requirements of ANSI B31.1., Owner's specifications, and the contractor's Inspection and Test Plan.
- .2 Test pressure shall be 1.5 times the system design pressure. Hydro test water shall be clean, filtered fresh or city water. There shall be no leakage in the pipeline.
- .3 All District Heating primary piping shall be hydraulically tested after installation and before painting, insulating, and concealing in any way, at a minimum test pressure of 2400 kPa for 4 hours without a drop in pressure.
- .4 Any equipment not capable of withstanding the designated test pressure shall be isolated. Flow meters, heat exchangers, and control valves are to be removed and spool pieces installed before commencing pressure tests.
- .5 The Design Engineer shall make the contractor responsible for obtaining all approvals from jurisdictional bodies for the carrying out of pressure tests on all piping with joints and visual examination as per B31.1.

## 17.0 Radiographic Testing

- .1 100% of all primary buried welds shall be radiograph tested.
- .2 20% of all primary non buried welds shall be radiograph tested. If any welds are shown to fail a second test will be required with radiograph of 100% of welds.

## 18.0 Cleaning and Flushing

- .1 The Design Engineer and Campus Chief Engineer shall review and approve the contractor's flushing procedure.
- .2 Primary piping shall be flushed, with a chemical flush and then with potable water, to remove all foreign material from the inside of all piping to the Design Engineer's approval. Flushing velocity shall be a minimum of 1.5 m/s.
- .3 Typical acceptable system water concentrations:
  - Iron levels should be below 2 ppm.
  - Hardness should be below 2 ppm.
  - Chloride levels should be maximum 250 ppm if 316 SS Heat Exchanger plate material is used or 50 ppm for 304 SS.
  - pH level of 9.5-10
- .4 Water is to be tested by a water treatment analyst during the cleaning and flushing procedure.
- .5 The Contractor shall take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation. Flow meters, heat exchangers, and control valves are to be replaced with spool pieces.
- .6 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.

## 19.0 Commissioning

- .1 Prior to the commissioning of the DES system, the system must be flushed and cleaned to the satisfaction of the Owner.
- .2 After satisfactory water quality analysis by a qualified water treatment contractor, system start-up and commissioning may commence. A certification from the water treatment contractor will verify that the water quality is acceptable.

## 20.0 Accessibility

- .1 All buried valves shall have a *10" valve box with cast lid. Lid to be have the identification letters DES permanently etched on with welded letters. Valve boxes in brick shall be square with a round lid. Acceptable materials: Dobney Foundry MR10-18B or equivalent.*





Most Common installation



Installation in Brick

## 21.0 Chemical Addition

- .1 Contractors are required to add the appropriate quantity of chemical to the district piping to prevent corrosion. The Chemical type to be used must be confirmed prior to introducing to the system to prevent adverse effects of mixing chemicals. Alternative options are available providing prior arrangements have been made with Campus Chief Engineer.

**\*\*\*END OF SECTION\*\*\***