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Gatineau, Québec K1A 0S5

SOLICITATION AMENDMENT MODIFICATION DE L'INVITATION

The referenced document is hereby revised; unless otherwise indicated, all other terms and conditions of the Solicitation remain the same.

Ce document est par la présente révisé; sauf indication contraire, les modalités de l'invitation demeurent les mêmes.

Comments - Commentaires

This document contains a security requirement.

Ce document contient une condition de sécurité.

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11 Laurier St./11 Rue Laurier

3C2, Place du Portage

Phase III

Gatineau, Québec K1A 0S5

Title - Sujet Building Conversion Pilot Project	
Solicitation No. - N° de l'invitation EP635-172555/A	Amendment No. - N° modif. 004
Client Reference No. - N° de référence du client 20172555	Date 2017-03-08
GETS Reference No. - N° de référence de SEAG PW-\$\$\$FG-363-72378	
File No. - N° de dossier fg363.EP635-172555	CCC No./N° CCC - FMS No./N° VME
Solicitation Closes - L'invitation prend fin at - à 02:00 PM on - le 2017-03-14	Time Zone Fuseau horaire Eastern Standard Time EST
F.O.B. - F.A.B. Plant-Usine: <input type="checkbox"/> Destination: <input type="checkbox"/> Other-Autre: <input type="checkbox"/>	
Address Enquiries to: - Adresser toutes questions à: Boivin, Emmanuelle	Buyer Id - Id de l'acheteur fg363
Telephone No. - N° de téléphone (819) 420-5352 ()	FAX No. - N° de FAX (819) 956-8335
Destination - of Goods, Services, and Construction: Destination - des biens, services et construction: Taxation data centre 875 Heron, Ottawa, Ontario	

Instructions: See Herein

Instructions: Voir aux présentes

Delivery Required - Livraison exigée	Delivery Offered - Livraison proposée
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Name and title of person authorized to sign on behalf of Vendor/Firm (type or print) Nom et titre de la personne autorisée à signer au nom du fournisseur/ de l'entrepreneur (taper ou écrire en caractères d'imprimerie)	
Signature	Date

Solicitation No. - N° de l'invitation
EP635-172555/A

Amd. No. - N° de la modif.
004

Buyer ID - Id de l'acheteur
FG-363

Client Ref. No. - N° de réf. du client

File No. - N° du dossier

CCC No./N° CCC - FMS No./N° VME

AMENDMENT 004

This amendment no 004 is raised to change the Invitation to Tender (ITT) as follows.

1) This amendment is raised to issue Addendum # 2.

All other terms and conditions remain the same.

ADDENDUM No.: 0002

Project Number: R.082110.001

The following changes in the bid documents are effective immediately. This addendum will form part of the contract documents.

SPECIFICATIONS

1.0 Refer to Section 01 32 16.07, Clause 1.4 - ACTION AND INFORMATIONAL SUBMITTALS:

ADD

- .4 Submit preliminary Shop Drawings to Departmental Representative within 20 working days of Notice of Contract Award. Subsequent Shop Drawing submissions to be relative to project milestones.

2.0 Refer to Section 23 09 33 - Clause 1.3 - DESIGNATED CONTACTOR:

ADD

- .2 Hire the services of R&R Automation or its authorized representative to complete the work of specification Section 25 30 02, Clause 2.7.

3.0 DELETE:

- **Section 23 21 13.02 - HYDRONIC SYSTEMS STEEL**

4.0 DELETE (and REPLACE upon reissue):

- **Section 23 05 23.03 - VALVES – CAST STEEL**
- **Section 23 05 23.05 - BUTTERFLY VALVES**
- **Section 23 20 13 - HIGH PRESSURE PIPING SYSTEMS INSIDE BUILDINGS AND CHC PLANTS**

5.0 Refer to Section 23 21 23, Clause 3.4 - VFD INSTALLATION AND SUPPORT:

ADD

- .10 VFD drives to be all from the same manufacture for both pump mounted and remote mounted equipment.

6.0 Refer to Section 23 21 14 – Clause 2.3 - AUTOMATIC AIR VENT:

Subsection: .4 – Design Pressure:

DELETE

- .3 For cooling water piping: 1,100 kPag at 15°C.

REPLACE

- .3 For cooling water piping: 1,035 kPag at 15°C.

7.0 Refer to Section 23 57 00 – Clause 2.4 - PLATE AND FRAME HEAT EXCHANGERS – CHILLED WATER:

Subsection: .7

DELETE

- .1 1,100 kPag; 15°C chilled water.

REPLACE

- .1 1,035 kPag; 15°C chilled water.

8.0 Refer to Section 23 57 00 – HEAT EXCHANGERS:

ADD

Clause 2.5 – TABLE

Equipment Tag	Maximum Dimensions			Maximum Weight
	Length	Width	Height	
HX-1	420 mm	201 mm	747 mm	
HX-2A/B	596 mm	363 mm	864 mm	
HX-3A/B	596 mm	363 mm	864 mm	
HX-4A/B	596 mm	363 mm	864 mm	
HX-5A	4067 mm	790 mm	2101 mm	7000 kg

9.0 Refer to Section 25 05 01, Clause 1.6 - ACTION AND INFORMATIONAL SUBMITTALS:

DELETE

- .2 Submit for Review:

- .1 Equipment list with systems manufacturers at time of tender.
- .2 List existing field control devices to be re-used included in tender, along with unit price.

10.0 Refer to Section 25 05 60 – Clause 1.3 - SYSTEM DESCRIPTION:

Subsection: .2 – Mechanical:

DELETE

- .2 Wells and Control Valves Shall Be Supplied by and Installed by EMCS Division 23.

REPLACE

- .2 Wells and Control Valves Shall Be Supplied by Division 25 and Installed by Division 23.

11.0 Refer to Section 25 90 01 – Clause 1.4 - POINT SUMMARY TABLES:

ADD

- .4 Provide Analog Output (AO) and Trend points for all new control valves for AHU-7,8,9,10 and 11 (Total of 8 valves).

DRAWINGS

MECHANICAL

1.0 M001 – MECHANICAL LEGENDS AND DRAWINGS LIST

- Gate Valve in General Symbols Legend should read Isolation Valve.
- Cooling Water Design Pressure to be revised from 1100 kPa to 1035 kPa.

2.0 M501 – MECHANICAL SCHEDULES NEW:

- Control valves for AHU-9, MAU-10 and MAU-11 to be pressure independent control valves.
- Replace Control Valves for AHU-7 and 8 with new pressure independent control valves.
- Expansion Tanks ET-38 & 39 –maximum volume 800L, size to match existing ET-28 & 29.
- Add Expansion Tank ET-40 - maximum volume 1000L, locate and connect to adjacent existing tanks ET-30 & 31.

CLARIFICATION No.: 001

SPECIFICATIONS

1.0 Section 01 00 10 - GENERAL INSTRUCTIONS

The intention of the 3D laser scan (3DLS) and Open BIM model is to assist with the constructability of the project. A professional engineering stamp on the model is not a requirement. Equipment fabrication with long lead times may need to be ordered prior to the open BIM model completion to meet the project schedule.

2.0 Section 01 00 10 - GENERAL INSTRUCTIONS

High Temperature Hot Water (HTHW), District Heating Water (DHS/R) and Primary Heating Water are all used interchangeably within the contract documents. The existing primary heating system piping is currently labeled as HTHW, however, District Heating Water is to be used for labeling at project completion for primary heater water as identified in Section 23 05 53.01.

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 21 05 01 – Common Work Results for Mechanical.
- .2 Section 23 05 05 – Installation of Pipework.
- .3 Section 23 20 13 – High Pressure Piping Systems.
- .4 Section 23 21 13.02 – Hydronic Systems: Steel.
- .5 Section 23 21 14 – Hydronic Specialties.
- .6 Section 25 30 02 – EMCS: Field Control Devices.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
 - .1 ASME B16, Fittings and Valves Package.
 - .2 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - .3 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
 - .4 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .5 ANSI/ASME B16.34-2013, Valves Flanged, Threaded and Welding End.
- .2 American Petroleum Institute (API):
 - .1 API STD 598-2009, Valve Inspection and Testing.
- .3 ASTM International:
 - .1 ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .2 ASTM A182/A182M-16, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
 - .3 ASTM A193/A193M-16, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A194/A194M-16, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
 - .5 ASTM A216/A216M-16, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .6 ASTM B85/B85M-14, Standard Specification for Aluminum-Alloy Die Castings.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
 - .1 MSS SP-25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2013, Pressure Testing of Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for each valve type and application and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide submittals in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations.
 - .2 Store and protect valves from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .3 Develop Construction Waste Management Plan related to Work of this Section.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products**2.1 MATERIAL**

- .1 Valves:
 - .1 To be of single manufacturer.
 - .2 Test valves individually.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.

- .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
- .9 CRN registration number required for all products.

2.2 GATE VALVES

- .1 Application: Primary heating systems.
- .2 NPS 2 and smaller, ANSI Class 800, A105 forged steel body, bolted bonnet, full port OS&Y rising stem, flexible wedge gate, flanged connections, and designed to operate in saturated steam service.

2.3 ISOLATION BALL VALVES

- .1 Application: Primary heating & cooling, secondary heating & cooling systems
- .2 NPS 2 and smaller: Threaded, 3 piece, Class 600, ball valve,; stainless steel body and ball, multi seal seat, PTFE packing, blow-out proof steam design, lever handle.
- .3 NPS 2 1/2 to 12: Design Pressure Class PN 25, working pressure 1600 kPag at 180°C sch. 40 butt welded ends (match pipe wall thickness), steel body, stainless steel ball and stem, Teflon seat, reduced bore, Class 300.
- .4 Valve stems to be sufficiently long to clear insulation.
- .5 Manual lever actuator with memory stop for sizes NPS 6 and below,
- .6 Weather proof worm gear operator to be provided for valve sizes NPS 8 and above;
- .7 Operator: see elsewhere in this Section.

2.4 DRAIN AND VENT VALVES

- .1 Application: Primary heating & cooling, secondary heating & cooling systems.
- .2 NPS ½ to 1:
 - .1 Threaded, 2000 psig WOG, ball valve, cold non-shock, carbon steel body, RTFE seats and seals, blow-out proof steam design, lever handle.
 - .2 Automatic float style vent valves shall be used as indicated on drawings. An upstream manual valve shall be provided for isolation.

2.5 GLOBE VALVES

- .1 Application: Heating Water, Chilled Water HTHW.
- .2 Up to and including NPS 2: Globe Valves Class 800 forged steel body, socket weld ends.
- .3 NPS 2 1/2 - 12, rising stem, OS Y, flanged ends, Class 300:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB.
 - .2 Body/bonnet joint: flat face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.
 - .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
 - .5 Stuffing box: including non-galling two-piece ball-jointed packing gland, with swing-type eye bolts and nuts.
 - .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.

- .7 Yoke bushing: Ni-Resist, minimum melting point above 954 degrees C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: ball type with 35 degrees' taper seat.
- .10 Seat rings: with 1.6 mm thick cobalt-chromium-tungsten alloy facings with minimum hardness of 375 HB (cold), slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with bonnet bushing, long engagement with yoke bushing for accurate seating, accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut.
- .12 Operator: see elsewhere in this Section.

2.6 VALVE OPERATORS

- .1 Application: Primary heating & cooling, secondary heating & cooling systems
- .2 Handwheel: on all valves
- .3 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.
- .4 Motors:
 - .1 Application: full open and full close applications.
 - .2 Position and precision control.
- .5 For control valve applications and details, refer to Section 25 30 02 – EMCS: Field Control Devices.

2.7 BYPASSES FOR VALVES

- .1 Application: Primary heating & cooling, secondary heating & cooling systems.
- .2 Locations: on valves as indicated.
- .3 Size of bypass valve:
 - .1 Main valve up to NPS 8: NPS 3/4.
 - .2 Main valve NPS 10 and over: NPS 2.
- .4 Type of bypass valves:
 - .1 On gate valve: gate, as per this section.
 - .2 On globe valve: gate, as per this section.

2.8 CHECK VALVES

- .1 Application: Primary heating systems:
 - .1 NPS 2 1/2 and over, non-slam, flanged ends, Class 300: swing check.
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Hinge: ASTM A182/A182M.
 - .8 Hinge pin: ASTM A182/A182M.

- .9 Hinge pin plugs: ASTM A182/A182M.
- .2 Application: Primary cooling, secondary heating & cooling systems:
 - .1 NPS 1/2 to 1-1/2:
 - .1 Class 800, "Y" pattern, swing type, screwed ends, forged steel body, 316 stainless steel regrindable type disc and seat of screw-in cap, stop plug.
 - .2 NPS 2 and over:
 - .1 Class 300, non-slam, flanged ends, with body and plate of ASTM A216/A216M WCB cast carbon steel, pin and spring of type 316 stainless steel, pin retainer of carbon steel, stop of nickel plated steel, seat of Buna-N.

2.9 SILENT CHECK VALVES

- .1 Application: Heating Water and Chilled Water.
- .2 Construction:
 - .1 Body: cast steel with integral seat.
 - .2 Pressure rating: Class 250.
 - .3 Connections: flanged ends.
 - .4 Double bronze disc with SS seat and stem. Renewable disc, seat, stem and spring. Spring rating must match system design for silent operation and installation.
 - .5 Stainless steel spring, heavy duty.
 - .6 Seat: regrindable.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.
- .2 For welded ended valves, valves should be open during welding and heat transfer to valve minimized during installation, as per manufacturer's recommendations.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by valve installation.

3.5 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Related sections
 - .1 Section 01 78 00 - Closeout Submittals
 - .2 Section 01 33 00 - Submittal Procedures
 - .3 Section 01 61 00 - Common Product Requirements
 - .4 Section 01 74 21 - Construction/Demolition Waste Management and Disposal
 - .5 Section 01 74 11 – Cleaning
 - .6 Section 21 05 01 – Common Work Results for Mechanical.
 - .7 Section 23 05 05 – Installation of Pipework.
 - .8 Section 23 20 13 – High Pressure Piping Systems
 - .9 Section 23 21 13.02 – Hydronic Systems: Steel
 - .10 Section 23 21 14 – Hydronic Specialties

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1-1983 (2013), Pipe Threads, General Purpose (Inch).
 - .2 ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25,125 and 250.
 - .3 ANSI/ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS ½ through 24.
 - .4 ANSI/ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.
 - .5 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .6 ANSI/ASME B16.34-2013, Valves - Flanged, Threaded and Welding Ends.
- .2 American Petroleum Institute (API)
 - .1 API Std. 609-09, Butterfly Valves: Double Flanged, Lug- and Wafer-Type.
- .3 ASTM International Inc.
 - .1 ASTM A 126 (2014), Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - .2 ASTM A 536-84 (2014), Standard Specification for Ductile Iron Castings.
 - .3 ASTM B 62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .4 ASTM B 209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate Metric.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-67-2011, Butterfly Valves.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit data for valves specified in this section.
- .3 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
- .2 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.

Part 2 Products**2.1 BUTTERFLY VALVES - DOUBLE OFFSET - 1100 kPag**

- .1 Application: Primary Chilled Water, secondary Heating Water and Chilled Water.
- .2 Except to specialty valves, to be of single manufacturer.
- .3 To be installed between weld neck flanges.
- .4 To be suitable for dead-end service.
- .5 CRN registration number required for products.
- .6 Sizes:
 - .1 Lug type: NPS 2-1/2 to 30.
- .7 Pressure rating for tight shut-off at temperatures up to maximum for seat material.
 - .1 NPS 2 - 12: 1100 kPag.
 - .2 NPS 14 - 48: 1100 kPag.
- .8 Minimum close-off pressure of 345 kPag required.
- .9 Minimum seat temperature ratings to 100 degrees C.
- .10 Application: on-off operation.
- .11 One-piece full lug body.
- .12 Operators:
 - .1 NPS 2 - 30: manual enclosed gear operator
 - .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in mechanical equipment rooms.
- .13 Designed to comply with MSS SP-67 and API 609.
- .14 Compatible with ANSI Class 125/Class 150 flanges.
- .15 Construction:
 - .1 Body: ductile iron.
 - .2 Disc: aluminum bronze, 316 SS or coated ductile iron.
 - .3 Seat: EPDM
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS
- .16 Actuators: Refer to Section 25 30 02 – EMCS: Field Control Devices.

2.2 BUTTERFLY VALVES - Double Offset - 2000 kPagPSIG

- .1 Application: Primary Heating Water.
- .2 Except to specialty valves, to be of single manufacturer.
- .3 To be installed between weld neck flanges.
- .4 To be suitable for dead-end service.
- .5 CRN registration number required for products.
- .6 Sizes:
 - .1 Lug type: NPS 2 to 48.
- .7 Pressure rating: 2000 kPag at 180 degrees C.
- .8 Lug body: 300 ANSI bolt pattern.

- .9 Application: for on-off service.
- .10 Operators:
 - .1 NPS 2 - 6: handles capable of locking in any of ten (10) positions - 0 degrees to 90 degrees. Handle and release trigger - ductile iron. Return spring and hinge pin: carbon steel. Latch plate and mounting hardware: cadmium plated carbon steel.
 - .2 NPS 8 - 24: manual enclosed gear operator actuators].
 - .3 Install parallel or perpendicular to pipeline.
- .11 Designed to comply with MSS SP-67 and API Std. 609.
- .12 Construction:
 - .1 Body: ductile iron
 - .2 Disc: aluminum bronze, 316 SS or coated ductile iron.
 - .3 Seat: EPDM
 - .4 Shaft: 316 stainless steel.
 - .5 Taper pin: 316 SS
- .13 Actuators: Refer to Section 25 30 02 – EMCS: Field Control Devices.

2.3 MOUNTING FLANGES

- .1 Class 150 steel to B16.5 pipe flanges or Class 300 steel, as required.

Part 3 Execution

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.
- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 ACTUATOR INSTALLATION

- .1 Air hoses or electrical connections to be made by actuator manufacturer.
- .2 Cycle valve operation from fully closed to fully open then back to fully closed.
- .3 At same time, check travel stop settings for proper disc alignment.

3.4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 07 84 00 - Fire Stopping.
- .2 Section 21 05 01 – Common Work Results for HVAC.
- .3 Section 23 05 17 - Pipe Welding.
- .4 Section 23 05 05 Installation of Pipework.
- .5 Section 23 05 16 – Expansion Fittings and Loops for HVAC Piping.
- .6 Section 23 05 19.01 – Thermometers and Pressure Gauges – Piping Systems.
- .7 Section 23 05 23.03 Valves – Steel.
- .8 Section 23 05 23.05 Butterfly Valves.
- .9 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Iron and Steel Institute (AISI).
- .2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME):
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ASME B31.1-2016, Power Piping.
 - .3 ASME B31.9-2014, Building Services Piping.
- .3 ASTM International:
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .2 ASTM A105/A105M-14, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .3 ASTM A106/A106M-14, Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service.
 - .4 ASTM A181/A181M-14, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - .5 ASTM A193/A193M-14a, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - .6 ASTM A194/A194M-14a, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - .7 ASTM A216/A216M-16, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .8 ASTM A234/A234M-15, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - .9 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .10 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.
 - .11 ASTM B61-08(2013), Standard Specification for Steam or Valve Bronze Castings.

- .4 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-14.5-M88, Thermometers, Bimetallic, Self-Indicating, Commercial/Industrial Type.
- .5 CSA International:
 - .1 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
- .6 Department of Justice Canada (Jus):
 - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
 - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 Health Canada/Workplace Hazardous Materials Information System (WHMIS):
 - .1 Material Safety Data Sheets (MSDS).
- .8 Public Works and Government Services Canada (PWGSC):
 - .1 Real Property Branch / Professional and Technical Services / Architecture and Engineering Resources / Mechanical and Maintenance Engineering / Utilities Engineering (RPB/PTS/AER/MME/Utilities Engineering).
 - .2 Real Property Branch / Property and Facilities Management / Operational Support Services / Utilities Management Services (RPB/PFM/OSS/Utilities Management Services).
- .9 Transport Canada (TC):
 - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 21 05 01 – Common Work Results for HVAC.
- .2 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Provide two (2) copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and 01 35 43 - Environmental Procedures.
- .4 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.
 - .1 Include in shop drawings: plans, elevations, sections, piping isometrics, construction details, of following:
 - .1 Prefabricated sections with field connection points.
 - .2 Branch connections.
 - .3 Equipment connections.
 - .4 Pipe supports.
 - .5 Expansion joints, anchors and guides. Include relevant engineering data.
 - .6 Include relevant engineering data.
 - .7 Expansion loops, anchors and guides.

- .8 Flash tanks.
 - .9 Vents, drains.
 - .10 Pipeline identification data.
 - .2 Shop drawings for alternative systems for expansion loops as approved by Departmental Representative before fabrication, to include:
 - .1 Calculations based on temperature between -18 degrees C and system operating temperature plus 25%.
 - .3 Construction Waste Management:
 - .1 Submit project Waste Management Plan, Waste Reduction Work plan highlighting recycling and salvage requirements.
 - .2 Submit calculations on end-of-project recycling rates, salvage rates, and landfill rates demonstrating that 50% of construction wastes were recycled or salvaged.
 - .4 Building Energy and Water Consumption: for monitoring of following end-uses:
 - .1 Heating water energy use.
 - .2 Cooling water energy use.
 - .3 Secondary systems make-up water use.
- .5 Submit for approval and registration (P number) assigned plans and specifications of new high pressure (HP) steam, HTHW systems to authorities having jurisdiction before beginning Work. TSSA fee for drawing and specification review to be covered by Contractor.
- .6 Proposed alterations to existing high pressure system are to be reviewed by certified boiler inspector of authorized insurance company under contract with PSPC. If existing system was registered (and a P# exists), they will prepare a Piping Data Report using the P# of existing system and submit it to Provincial Authority. They may require registration of existing system or a drawing be prepared and stamped by a Professional Engineer showing proposed changes.
- .7 Once approved drawings are received, construction may proceed with quality control and compliance to specs provided by Departmental Representative for in-house project.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide submittals in accordance with Section 21 05 01 – Common Work Results for HVAC, supplemented with:
 - .1 Information relating to elevations, inverts and location of piping, branches, anchors, expansion joints, loops.
 - .2 Valve data.
 - .3 Details of permanent instrumentation.
 - .4 Details of permanent provisions for temporary instrumentation.
 - .5 Access points.
 - .6 Details of pipe grades, vents, drip points.
 - .7 Drainage provisions at low points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:

- .1 Valve seats: one (1) for every ten (10) valves, each size. Minimum: one (1).
- .2 Balls: one (1) for every ten (10) valves, each size. Minimum: one (1).
- .3 O-Rings: one (1) for every twenty (20) of each type and size supplied. Minimum: two (2).
- .4 Valve handles: two (2) of each size.
- .5 Flange gaskets: one (1) for every ten (10) flanged joints. Minimum two (2).
- .6 Strainer meshes: one (1) for every five (5) strainers of each size. Minimum: one (1).
- .3 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

1.6 **QUALITY ASSURANCE**

- .1 Regulatory Requirements: ensure Work is performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.
- .2 Inspections:
 - .1 Inspect new piping prior to hydrostatic test by authority having jurisdiction. Where Province has approved drawings, TSSA certified boiler inspector to inspect installation.
 - .2 Contractor to contact TSSA for requirements for inspection and testing of system modifications, design changes or repairs done in house.
 - .3 Costs for inspection to be covered by Contractor.

1.7 **DELIVERY, STORAGE AND HANDLING**

- .1 In accordance with Section 23 05 01 – Common Work Results for HVAC.
- .2 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .3 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .4 The Departmental Representative reserves the right to delay delivery of the equipment up to thirty (30) days at no cost to the Departmental Representative.
- .5 Be responsible for coordinating delivery, unloading and storage Departmental Representative supplied materials and delivery of such materials from the pre-approved laydown area (to be determined post contract award) to the installation.
- .6 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .7 Develop Construction Waste Management Plan and a Waste Reduction Work plan related to Work of this Section and in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.

- .8 Packaging Waste Management: remove for reuse and return to manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan and the Waste Reduction Work plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.8 WELDING

- .1 Refer to Section 23 05 17 – Pipe Welding.

Part 2 Products

2.1 GENERAL

- .1 Valves to be repackable under full line pressure while fully open.
- .2 Welding materials and labor must conform to ASME Code. Welders shall be fully qualified and licensed by Provincial Authorities. Pressure welders shall be used for contained pressure in excess of 100 kPa.
- .3 All penetrations through fire rated assemblies requires engineered fire stopping. Refer to original drawings, specifications and details regarding fire stopping requirements.
- .4 High Temperature Hot Water, Heating Water and Chilled Water; All associated piping, fittings, valves, strainers, and other equipment in the hot water system to be designed, and approved to operate as a minimum up to:
 - .1 Refer to Drawing M001.
- .5 For domestic hot water systems, refer to Section 22 11 16 – Domestic Water Piping.

2.2 HIGH PRESSURE (OVER 860 KPA AND UP TO 1725 KPA) LOW TEMPERATURE HOT WATER (UP TO 120 DEGREES C)

- .1 Application: primary chilled water, secondary chilled/heating water and glycol systems.
- .2 All piping, fittings, valves, strainers, and other equipment of these systems to be designed, and installed in accordance with ASME Code for Building Services Piping B31.9.
- .3 Piping:
 - .1 To ASTM A53/A53M, Grade B.
 - .2 NPS 1/2 to 1-1/2: Schedule 80, screwed.
 - .3 NPS 2 to 10: Schedule 40, ERW or Seamless, bevel ends.
 - .4 NPS 12 and over: 9.6 mm wall thickness ERW or seamless.
- .4 Fittings:
 - .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, screwed fittings with PTFE tape or lead free pipe dope.
 - .2 NPS 1-1/2 to and including NPS 2: Class 3000, forged socket weld ends, dimensions to ASME B16.11, to ASTM A105 for carbon steel piping; TP304 for stainless piping.
 - .3 NPS 2-12: Schedule 40, bevel ends, to ASTM A234/A234M, Grade WPB.
 - .4 NPS 14 and over: 9.6 mm wall thickness, bevel ends, to ASTM A234/A234M, Grade WPB.
- .5 Elbows are long radius only.

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- .6 Couplings, Caps, Plugs:
 - .1 NPS 1/2 to 2: Class 3000, 20 MPa, socket weld ends, to ASTM A105. Dimensions per ANSI B16.11.
 - .7 Nipples for drains, vents, pressure gauges, similar items:
 - .1 NPS 1/2 to 1-1/2: Schedule 80, screwed, to ASTM A53/A53M, Grade A.
 - .8 Unions:
 - .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, screwed ends, forged steel, steel-to-steel ground joints, to ASTM A105/A105M.
 - .9 Flanges:
 - .1 Class 150:
 - .1 NPS 1/2 to 2: raised face, socket welded ends, to ASTM A105/A105M for carbon steel piping; TP304 for stainless piping.
 - .2 NPS 2-1/2 and over: raised face, weld neck, bored to suit pipe, to ASTM A105/A105M, dimensions to ANSI B16.5.
 - .10 Studs, Bolts and Nuts:
 - .1 Stud bolts, carbon steel, semi-finished with heavy hex nuts, to ASTM A307, Grade B.
 - .2 Flange to Flange: All sizes:
 - .1 Alloy steel studs, semi-finished with two (2) heavy hex nuts.
 - .2 Material: ASTM A193 B7M studs, c/w A194 2HM nuts.
 - .3 Lug Body Valves: All Sizes:
 - .1 Alloy steel stud with hex head cap, semi-finished with one (1) heavy hex.
 - .11 Gaskets:
 - .1 Spiral wound 304 stainless steel rated for pressure and temperature of system.
 - .2 Raised Face Flanges (RF)/Flat Faced Flanges (FF):
 - .1 Nitrile-binded with aramid & glass fibre, non-asbestos standard with NST non-stick coating for ease of removal.
 - .3 1.6 mm (1/16") thick, ringed, rated for service, temperature and pressure of fluid.
 - .4 Max Allowable Creep Relaxation: 21%.
 - .5 Hot Compression Test-Maximum Allowable Thickness Loss: 27%.
 - .6 Dimensions: to ANSI B16.21.
 - .7 Installation: to Manufacturer's recommendation for bolt strength and seat stress.
 - .8 Acceptable materials:
 - .1 Flexitallic SF 3300 to suit RF/FF flange type.
 - .2 Klingsil C-4401 to suit RF/FF flange type.
 - .3 Garlock 5500/3760 to suit RF/FF flange type.
 - .12 Control Valves:
 - .1 As specified in Section 25 30 02 – EMCS: Field Control Devices.
 - .13 Energy Meters:
 - .1 As specified in Section 25 30 02 – EMCS: Field Control Devices.
 - .14 Y-Strainers:
 - .1 NPS 2-½ and larger:

- .1 Cast Steel body, Welded ends to match pipe, Y-pattern, complete with valved drain connection, stainless steel perforated screen with 20 mesh (0.7 mm). Screen area shall be minimum three times area of inlet pipe. Class 150 for 1,100 kPa and 120°C.
 - .2 NPS 2 and smaller:
 - .1 Cast steel, Y-pattern, threaded ends, stainless steel perforated screen with 30 mesh (0.5 mm), ANSI Class 150 for 1,600 kPa and 120°C.
- .15 Start-up Strainers:
 - .1 Removable cone style.
 - .2 Material: Stainless Steel. 3.96mm perforation size standard. Use 0.7mm perforation size in front of plate exchangers.
- .16 Control Valves:
 - .1 As specified in Section 25 30 02 – EMCS: Field Control Devices.
- .17 Check Valves:
 - .1 As specified in Section 23 05 23.03 Valves – Cast Steel.
- .18 Butterfly Valves:
 - .1 As specified in Section 23 05 23.05 – Butterfly Valves.
- .19 Pressure Safety Relief Valves:
 - .1 Thermal Relief Hot Water Service: ASME Section VIII approved, 13 mm FNPT x 25 mm FNPT; Open lever, Carbon steel body, stainless steel spring, 1,600 kPag pressure rating. Orifice area is ASME “C” - 43 square millimeters’ minimum.
- .20 Needle Valves:
 - .1 Needle Valves: As specified in Section 23 05 19.01 – Thermometers and Pressure Gauges – Piping Systems.
- .21 Manual Air Vents:
 - .1 As specified in Section 23 05 23.03 Valves – Cast Steel.
 - .2 Automatic float style vent valves shall be used as indicated on drawings. An upstream manual valve shall be provided for isolation.
 - .3 Ball valves, NPS 1/2, Class 300, steel body, three (3) piece.
- .22 Thermometer Wells:
 - .1 As specified in Section 23 05 19.01 – Thermometers and Pressure Gauges – Piping Systems.
 - .2 Type 304 stainless steel; Lagging type.
- .23 Pressure Independent Flow Control Valves:
 - .1 Automatic flow control valve cartridges shall automatically control flow rates with $\pm 5\%$ accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Four operating pressure ranges shall be available with the minimum range requiring less than 21 kPa (3 PSI) differential to actuate the mechanism.
 - .2 Valve internal control mechanism shall consist of a stainless steel one-piece cartridge with segmented port design and full travel linear coil spring.
 - .3 Manufacturer shall be able to provide certified independent laboratory tests verifying accuracy of performance.

- .4 All flow control valve cartridges shall be warranted by the manufacturer for five years from date of sale.
- .5 Class 150 Flange End Valves shall consist of steel pipe with flange ends and supplied with dual pressure or pressure/temperature test valves for verifying accuracy of flow performance for all sizes.
- .6 Valves shall be permanently marked to show direction of flow and shall have body tag to indicate model number and flow rate.

2.3 HIGH PRESSURE (OVER 860 KPA AND UP TO 1725 KPA) HIGH TEMPERATURE HOT WATER (UP TO 215 DEGREES C)

- .1 Application: primary heating water systems.
- .2 All piping, fittings, valves, strainers, and other equipment of these systems to be designed, and installed in accordance with ASME Code for Power Piping B31.1.
- .3 Piping:
 - .1 To ASTM A106/A106M, Grade B.
 - .2 NPS 1/2 to 1-1/2: Schedule 80, seamless.
 - .3 NPS 2 to 10: Schedule 40, Seamless, bevel ends.
 - .4 NPS 12 and over: 9.6 mm wall thickness ERW or seamless.
- .4 Fittings:
 - .1 NPS 1/2 to 1-1/2: Class 3000, forged steel socket weld ends, to ASTM A181/A181M, Class 70.
 - .2 NPS 2 to 10: Schedule 40, seamless, bevel ends, to ASTM A234/A234M.
 - .3 NPS 12 and over: 10 mm wall thickness, seamless bevel ends, to ASTM A234/A234M.
- .5 Couplings:
 - .1 NPS 1/2 to 1-1/2: Class 3000, screwed ends, to ASTM A181/A181M, Class 70.
- .6 Caps, Plugs for drains, similar items:
 - .1 NPS 1/2 to 3/4: Class 3000, screwed, to ASTM A181/A181M, Class 70.
- .7 Nipples for drains, vents, pressure gauges, similar items:
 - .1 NPS 1/2 to 1-1/2: Schedule 80, screwed ends, to ASTM A106/A106M, Grade A.
- .8 Unions:
 - .1 NPS 1/2 to 1-1/2: Class 3000, screwed ends, forged steel, steel-to-steel ground joints, to ASTM A181/A181M, Class 70.
- .9 Flanges:
 - .1 NPS 1/2 to 1-1/2: Class 300, raised face, bored to match pipe, to ASTM A105/A105M.
 - .2 NPS 2 and over: Class 300, raised face weld neck, bored to suit pipe, to ASTM A181/A181M.
- .10 Studs, Bolts and Nuts:
 - .1 Alloy steel studs and bolts, to ASTM A193/A193M, Grade B7, with semi-finished heavy hex head nuts, to ASTM A194/A194M, Grade 2H.
- .11 Gaskets:
 - .1 Steel flex 1.6 mm thick, rated for pressure and pressure of system.

- .12 Energy Meters:
 - .1 As specified in Section 25 30 02 – EMCS: Field Control Devices.
- .13 Control valves: As specified in Section 25 30 02 – EMCS: Field Control Devices.
- .14 Check Valves: as specified in section 23 05 23.03 – Valves- Cast Steel.
- .15 Globe valves: as specified in section 23 05 23.03 – Valves- Cast Steel.
- .16 Butterfly Valves: as specified in Section 23 05 23.05 – Butterfly Valves.
- .17 Bypass valves: as specified in section 23 05 23.03 – Valves- Cast Steel.
- .18 Drain valves: as specified in section 23 05 23.03 – Valves- Cast Steel.
- .19 Strainers:
 - .1 NPS 1/2 to 1-1/2: Class 800, Y-type, screwed ends, body of forged steel, screen of monel or 304 stainless steel:
 - .1 Screen:
 - .1 Exposed area: Four (4) times cross-sectional area of pipe.
 - .2 Mesh: 0.84 mm diameter.
 - .2 NPS 2 and over: Class 300, Y-type, flanged ends, body of ASTM A216/A216M cast steel, screen of monel or 304 stainless steel:
 - .1 Screen:
 - .1 Exposed area: Four (4) times cross-sectional area of pipe.
 - .2 NPS 2 1/2 -4: 1.6 mm diameter.
 - .3 Over NPS 4: 3.2 mm diameter.
- .20 Manual Air Vents:
 - .1 Ball valves, NPS 1/2, Class 300, steel body, three (3) pieces.
- .21 Thermometer Wells:
 - .1 Type 304 stainless steel, lagging type.

2.4 ANCHORS, GUIDES, SLIDES

- .1 In accordance with Section 23 05 16 – Expansion Fittings and Loops for HVAC Piping.

2.5 EXPANSION LOOPS

- .1 Expansion loops in accordance with stress limits set out in ANSI/ASME B31.1.
- .2 In accordance with Section 23 05 16 – Expansion Fittings and Loops for HVAC Piping.
- .3 Provide as indicated, using distribution piping and fittings.

2.6 EXPANSION JOINTS

- .1 In accordance with Section 23 05 16 – Expansion Fittings and Loops for HVAC Piping.

2.7 BASES, HANGERS AND SUPPORTS

- .1 Conform to Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment supplemented as specified herein.
- .2 Provide to details as indicated.
- .3 Submit shop drawings for approval before fabrication.
- .4 Percussion type inserts not permitted.

- .5 Power driven fasteners not permitted.

2.8 THERMOMETERS

- .1 In accordance with Section 23 05 19.01 – Thermometers and Pressure Gauges – Piping Systems.

2.9 PRESSURE GAUGES

- .1 In accordance with Section 23 05 19.01 – Thermometers and Pressure Gauges – Piping Systems.

2.10 FABRICATION

- .1 Do work in accordance with ASME B31.1.
- .2 Joints:
 - .1 Accessible locations: screwed, flanged or welded to match piping specification.
 - .2 Elsewhere: welded throughout, except at flanged components.
- .3 Carbon Steel Screwed joints:
 - .1 To ANSI/ASME B1.20.1.
 - .2 Provide clean machine-cut threads.
 - .3 Use PTFE tape or lead-free pipe dope or paste on male threads.
- .4 Branch Connections:
 - .1 Use butt or socket-weld fittings.
 - .2 Mains NPS 2-1/2 and smaller: use weldolets, threadolets, or 2 Mpa half couplings as reinforcements.
 - .3 Mains NPS 3 and larger: welded branch connections can be used.
 - .4 In grooved systems: tees and reducing tees can be used.
- .5 Welding:
 - .1 Conform to all requirements of Section 25 05 17 - Pipe Welding.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions:
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative/DCC Representative/Consultant.

3.2 PREPARATION

- .1 Lay out work in accordance with lines and grades as indicated.
- .2 Verify lines, levels, dimensions as indicated against established benchmarks. Report discrepancies to Departmental Representative and obtain written instruction.

- .3 When required by Departmental Representative, provide drawings showing relative locations of various services.

3.3 WELDING

- .1 Perform welding in accordance with Section 23 05 17 - Pipe Welding supplemented as specified herein.
- .2 Notwithstanding the requirements of referenced section, the following shall apply:
 - .1 Welding to be in accordance with ASME B31.1 or ASME B31.9, as indicated in Part 2.
 - .2 Welding to be executed by certified pipe welders.
 - .3 Pipe fitting to be executed by certified pipe fitters.

3.4 INSTALLATION

- .1 Installation to be performed by certified steam fitters.
- .2 Install pipework in accordance with Section 23 05 05 - Installation of Pipework, as supplemented herein.
- .3 Connections to equipment to be strain free. "Set Up" prior to connecting is an inspection point.
- .4 Maintain clearances between pipes as indicated.
- .5 Maintain clearance between pipes and structures for O&M as indicated, as directed.
- .6 Provide manual air vents, drains, drip legs, dirt pockets as specified and as indicated.
- .7 Seal piping passing through walls as indicated.
- .8 Provide for pipe movement as required and in accordance with installation instructions.
- .9 Provide manual air vents, drains, drip legs, dirt pockets as specified and as indicated.
- .10 Use eccentric reducers in horizontal piping to prevent accumulation of pockets of air and or to prevent the drain-down of water.
- .11 Weld couplings for drains into carbon steel piping to ASME B31.1, or ASME B31.9, as indicated on the drawings.
- .12 Carbon steel branch take-offs.
- .13 Refer to following table for approved methods of branch connections.
- .14 Provide drip legs, dirt pockets as indicated.
- .15 Flanges: use suitable graphite lubricant on bolts and nuts.
- .16 Remove all burrs from piping. Clean scale and dirt, inside and out before and after assembly.
- .17 Grade nominally horizontal piping at 0.5% slope generally in direction of flow.
- .18 Carbon steel Flanges: Tighten bolts evenly with torque wrench. Re tighten bolts with torque wrench after system is in operation.
- .19 Revisions to routing/location of piping require approval of Consultant.
- .20 Reducers at pump suction connections to be eccentric with flat on top.
- .21 Install piping to minimize pipe dismantling for equipment removal. This would include removable flanged spool sections as required.
- .22 Butterfly valves: install between weld-neck flanges.

- .23 Drain Valves:
 - .1 Install at low points in piping systems, at bottom of risers, at equipment, at section isolating valves and elsewhere as required.
 - .2 Pipe drain valves discharge separately to above floor drain. Discharge to be visible.
 - .3 Weld couplings for drains into piping to ASME B31.1, or ASME B31.9, as indicated on the drawings.
 - .4 Check operation after system is in use and under full pressure.
- .24 Provide for pipe movement as indicated and in accordance with expansion joint manufacturer's installation instructions.
- .25 Flexible Connectors / Expansion Joints:
 - .1 Install as per manufacturer's instructions.
 - .2 Remove expansion joints from piping before pressure testing. Do not expose expansion joints to test pressures.
 - .3 Bellows units must not be subjected to torsional forces.
 - .4 Reinstall bellows after hydro testing. Remove shipping tie rods after completion of satisfactory pressure testing of piping system.
- .26 Anchors and Guides:
 - .1 Locate anchors as required and shown.
 - .2 Align piping at guides so as to avoid damage by movement of piping against fixed structures.
 - .3 Guide expansion joints as per manufacturer's recommendations.
- .27 Manual Air Vents:
 - .1 Install at high points in piping systems and elsewhere as indicated.
 - .2 To consist of full size tee, pipe extension and accumulator, cap and shut off valve, discharge pipe to floor drains with visible termination.
- .28 Seal piping passing through walls with approved fire stopping compatible with surface temperature of pipe or insulation by others in accordance with Section 07 84 00 - Fire Stopping.
- .29 Branch Take-offs:
 - .1 Use welding tees.
 - .2 Where reducing tees of proper size are unavailable, use available tees with reducers. Tees with increasers not acceptable.
 - .3 Weldolets may be used at drip legs only provided ratio of outlet size to pipe size is 0.5 or smaller.
- .30 Remove all burrs from piping. Clean scale and dirt, inside and out before and after assembly.
- .31 Grade nominally horizontal piping at 0.5% slope generally in direction of flow.
- .32 Cap open ends of piping during installation. Remove foreign material from inside piping.
- .33 Flanges: tighten bolts evenly with torque wrench.
- .34 Connections to equipment:
 - .1 Use flanged valves for isolation and ease of maintenance and assembly.
 - .2 Use double swing joints and swing joints when equipment mounted on vibration isolation and when piping subject to movement.

- .35 Carbon Steel Flanges: Tighten bolts evenly with torque wrench. Re tighten bolts with torque wrench after system is in operation.
- .36 Removal of a portion of pipe to facilitate welding of the joint and then replacing the cut out section, sometimes called "fish mouth" or Window" welding will not be permitted.
- .37 The Contractor shall furnish and install all temporary devices such as pressure pumps, gauges, valves, caps and pipes, necessary for the conducting of the leak testing and flushing operations.
- .38 Revisions to location of piping require approval of Departmental Representative or Consultant.
- .39 Install piping to minimize pipe dismantling for equipment removal. This would include removable flanged spool sections as required.
- .40 Install concealed pipes close to building structure to keep furring space too minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .41 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .42 Assemble piping using fittings manufactured to ANSI standards:

Branch Connection Table

Branch Size	Header Size																
	NPS	½	¾	1	1-½	2	3	4	6	8	10	12	14	16	18	20	24
	½	T	TR	TR	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	¾		T	TR	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	1			T	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	1-½				T	TR	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO	SO/TO
	2					T	TR	TR	TR/SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W	SO/W
	3						T	TR	TR	TR/W	TR/W	W	W	W	W	W	W
	4							T	TR	TR	TR/W	W	W	W	W	W	W
	6								T	TR	TR	TR	W	W	W	W	W
	8									T	TR	TR	TR	TR	W	W	W
	10										T	TR	TR	TR	TR	TR	W
	12											T	TR	TR	TR	TR	TR
	14												T	TR	TR	TR	TR
	16													T	TR	TR	TR
	18														T	TR	TR
	20															T	TR
24																	T

T - Tee

TO - Thredolet

W - Weldolet

TR - Reducing Tee

SO - Sockolet

3.5 COLD SPRING

- .1 Except where cold springing is indicated or specified, do not force pipes into position.

3.6 PIPE SUPPORTS

- .1 In accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment, supplemented as specified herein.
- .2 Install to manufacturer's recommendations.

- .3 Spring hangers to remain blocked until completion of hydro test, after which initial free adjustments are to be made.
- .4 Adjust supports, hangers, and springs, with system at operating temperature.
- .5 Install expansion loops and supports as indicated and required to maintain venting and/or drainage.
- .6 Painting:
 - .1 Paint all hangers, supports, and all exposed steelworks with two (2) coats of rust inhibitive primer prior to commencement of insulation.

3.7 ANCHORS AND GUIDES

- .1 Locate anchors as required and shown.
- .2 Align piping at guides so as to avoid damage by movement of piping against fixed structures.
- .3 Guide expansion joints as per manufacturers' recommendations. To accommodate specified thickness of insulation.

3.8 VALVES

- .1 Install isolating valves at branch take-offs, at pieces of equipment and elsewhere as indicated.
- .2 Install in accordance with manufacturer's recommendations.
- .3 Install check valves as indicated for flow.
- .4 Install check valves on pump discharge in vertical pipes with upward flow and elsewhere as indicated.
- .5 Install in accessible locations with stem horizontal or above. Gate valve stems shall not be oriented horizontally in horizontal lines.
- .6 Screwed and flanged valves to be accessible for removal or maintenance without removing adjacent piping.
- .7 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.
- .8 Depending upon piping configuration and ease of operation, on horizontal pipes install with stem horizontal or above.
- .9 Valves to be accessible for maintenance without removing adjacent piping.

3.9 VALVED DRAINS

- .1 Locations:
 - .1 At bottom of risers.
 - .2 At low points in mains and branches.
 - .3 Elsewhere as indicated on drawings.
- .2 Discharge:
 - .1 Provide hose adapter on drain valves where discharge piping cannot conveniently be carried to floor drains.
- .3 Check operation after system is in use and under full pressure.

3.10 AIR VENTS

- .1 Install at high points and elsewhere as indicated on drawings.
- .2 Provide $\frac{3}{4}$ " pipe and needle valves between pipe wall penetration and interior isolation ball valves for air release at high points inside buildings as indicated as per drawing details.
- .3 To consist of tee, pipe extension, and shut off valve, discharge pipe to 400 mm above floor. The pipe end shall be provided with a threaded forged steel cap.

3.11 STRAINERS

- .1 Install in locations to allow easy access for removal of screen.
- .2 Provide Drain Ball Valve and piping to a point 400 mm from a floor drain. The pipe end shall be provided with a threaded forged steel cap.

3.12 INSTALLATION OF THERMOWELLS

- .1 In general, to be installed in elbows:
 - .1 Minimize turbulence and resistance to flow.
 - .2 Install in direction of flow.
 - .3 Full length of thermowell to be in the fluid being measured.
 - .4 Increase size of piping to ensure velocity of fluid at thermowell is equal to flow rate in adjacent piping.
- .2 Refer to drawings for details.

3.13 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove hand wheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.14 FIELD QUALITY CONTROL

- .1 Energy Metering:
 - .1 Primary measuring element to be as close as possible to entry into building.
- .2 Inspections:
 - .1 Leave joints in piping systems uncovered until tests are completed and system inspected as directed by Departmental Representative.
 - .2 All testing shall be witnessed by the Departmental Representative.
 - .3 Radiographic inspections:
 - .1 Notwithstanding inspection specified in Section 23 05 17 - Pipe Welding, carry out radiograph inspections of 30% of welds on steam, HP drip, pumped condensate return and HTHW piping to ASME B31.1.
 - .2 If joints on 10% radiographic test fail, radiograph joints performed by welder whose joint failed.
 - .3 Radiograph repaired joints to ASME B31.1.
 - .4 Perform Wet Dry magnetic particle tests on welded slip-on flanges.
 - .5 Submit results of radiographs, together with copy of welder's licence and description of procedures used, to inspector of insurance company under contract to PWGSC.

- .4 Authority having jurisdiction to inspect new piping prior to hydrostatic pressure tests for compliance with approved drawings and specifications.
- .5 Where Province has approved the drawings, TSSA certified boiler inspector to inspect installation.
- .6 Obtain from Departmental Representative requirements for inspection and testing of system modifications, design changes and repairs performed in-house.
- .7 Pay costs for inspections.
- .3 Hydrostatic Pressure Tests:
 - .1 Pressure tests are required to verify quality assurance.
 - .2 Pressure test all piping after installation and before painting, insulating, or concealing in any way, in accordance with Section 21 05 01 – Common Work Results for HVAC.
 - .3 Give Departmental Representative minimum of 48 hours notice of intention to perform pressure tests.
 - .4 After installation and before concealing, subject piping to hydrostatic pressure tests to 1.5 times maximum working pressure and maintain test pressure without loss for 24 hours.
 - .5 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or test media.
 - .6 Provide additional supports to steam piping as required and remove after testing is successfully completed.
 - .7 Conduct tests in presence of Departmental Representative.
 - .8 Bear costs for tests, for repairs or replacement, retesting, making good.
 - .9 Insulate or conceal work after approval and certification of tests by Departmental Representative.

3.15 TESTING

- .1 Test system in accordance with Section 21 05 00- Common Work Results for Mechanical.
- .2 For glycol systems, retest with ethylene or propylene, glycol, as per system type, to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.16 COMMISSIONING

- .1 Provide three (3) days written notice to Departmental Representative of intention to start up, test and adjust.
- .2 The Contractor shall coordinate all commissioning work with the Departmental Representative. The Contractor shall allow for returning to site to perform the commissioning process.
- .3 Start up systems only after written approval of installation from Departmental Representative.

3.17 START-UP

- .1 Provide continuous supervision during start-up.
- .2 Upon start-up, bring all mains up to temperature and pressure slowly.
- .3 Remove strainer baskets and clean during test and once more after first week of permanent operation.

- .4 After system is in operation and under maximum temperatures and pressures:
 - .1 Tighten all bolts on flanges, using torque wrench. Repeat several times during commissioning.
 - .2 Check operation of drain valves.
 - .3 Bleed air from system air vents as required.
- .5 Anchors, guides, supports:
 - .1 Monitor at all times during start-up and commissioning to ensure operation as designed.
 - .2 Adjust pipe supports, hangers, and springs.
 - .3 Full scale tests
- .6 Upon completion, conduct full scale tests at maximum design flow rates, operating temperatures and pressures for continuous consecutive period of 48 hours to demonstrate full compliance with design requirements.

3.18 PAINTING

- .1 Paint exposed steelwork with two (2) coats of rust inhibitive primer after construction and prior to beginning of insulation.

3.19 FLUSHING AND CLEANING

- .1 Flush and clean in accordance with Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems.
- .2 Flush:
 - .1 The contractor shall provide equipment, labour, and materials as needed to perform the flushing and cleaning of the process piping.
 - .2 Contractor shall provide a flushing/cleaning procedure to the consultant one (1) month prior to the completion of the piping installation.
 - .3 Secondary building piping shall be flushed with potable water then chemically cleaned to remove all foreign material from the inside of all piping to the consultant's approval.
 - .4 Equipment shall be bypassed during flushing/cleaning process and strainer screens temporarily removed.
 - .5 All instrumentation installed in the piping shall be removed and not be exposed to the flushing and cleaning process.
 - .6 Flushing velocity to be a minimum of 1.5 meters per second.
 - .7 Provide flushing screen 20 mesh on flush discharge to monitor material carried by flushwater.
 - .8 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.
 - .9 The contractor shall notify the consultant 24 hours in advance of the flushing / cleaning procedure.
 - .10 Following the fresh water flush a chemical cleaning of the piping will be conducted based on the recommendations of the water treatment specialist engaged by the installing contractor.
 - .11 On completion of Flushing/cleaning and acceptance by Site Engineer, re-connect equipment, clean and re-install temporary and permanent strainer screens.
 - .12 Temporary strainer screens shall remain in place up to six (6) months after start-up.

- .13 The Contractor shall take all necessary precautions to prevent damage to the pipe, insulation, or structures from the cleaning operation.
- .14 The Contractor shall take all necessary precautions to ensure that no oil or other lubricant comes into contact with either the inside or outside walls of the pipe.
- .15 The contractor shall install and remove all temporary piping and supports to introduce and dispose of flushing water at a safe discharge.
- .16 The contractor is responsible for obtaining and properly disposing of all test and cleaning media.

3.20 SYSTEM START-UP - GENERAL

- .1 Start-up systems after written approval of installation from Departmental Representative.
- .2 Start-up systems in accordance with Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems.
- .3 Provide three (3) days written notice to Departmental Representative of intention to start-up, and commission systems.
- .4 Timing after:
 - .1 Cleaning is completed.
 - .2 Pressure tests are completed.
 - .3 Joints radiographed as specified.
 - .4 Water treatment system has been commissioned.
 - .5 Painting of supports, steelwork to be completed before heat is applied to system.
- .5 Provide continuous supervision during start-up.

3.21 WATER TREATMENT SYSTEM

- .1 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.
- .2 Potable water system to be protected from heating systems using reduced pressure backflow preventers.
- .3 Provide sufficient corrosion coupons for two (2) years of monitoring.
- .4 Provide two (2) pressure gauges across each side stream filter case, complete with stainless steel wetted internals, isolating multipart stainless steel needle valves. Pressure rating is 860 kPag at 100 °C. Gauge range is 0 to 345 kPag.
- .5 The filter shall be installed with two (2) 50 mm ball valves for isolation to the discharge side of the pumps and a 50 mm globe valve for flow throttling on the suction side of the pumps.
- .6 Provide one (1) 50 mm union coupling between the ball valve and the filter housing on the low pressure side. Locate the coupling as close to the filter housing as possible.
- .7 Provide sufficient side filter elements/cartridges for commissioning, start-up, and normal operation for first twelve (12) months.
- .8 Install the bag filter elements in a properly sized part-flow by-pass across the pumps, as indicated. The filter should be isolated with a ball valve to the discharge side of the pumps, and a globe valve to the suction side of the pumps.

3.22 WATER TREATMENT SYSTEM FOR CLOSED HYDRONIC LOOP

- .1 Provide system initial fill with clean city water.

- .2 Provide and install the following components:
 - .1 Corrosion coupon monitoring system:
 - .1 To measure the rate of corrosion of copper and steel in the system.
 - .2 Sidestream Filter:
 - .1 Carbon steel filter housing and stainless steel perforated basket.
 - .2 Replaceable bag filter designed for 862 kPag at 100°C.
 - .3 Filter element performance, 500-micron absolute filter changeable to 5-20-micron nominal.
 - .3 Pot feeder for chemicals:
 - .1 Carbon steel construction.
 - .2 7.6 L capacity.
 - .3 Pressure rated to 862 kPag at 100°C.

3.23 WATER TREATMENT SYSTEM FOR CLOSED LOOP GLYCOL

- .1 Refer to Section 23 21 14 Hydronic Specialties for description of automatic glycol makeup package.
- .2 Provide system initial fill to percentage of propylene or ethylene glycol solution to match existing system.
- .3 Provide and install the following components:
 - .1 Corrosion coupon monitoring system:
 - .1 To measure the rate of corrosion of copper and steel in the system.
 - .2 Sidestream Filter:
 - .1 Carbon steel filter housing and stainless steel perforated basket.
 - .2 Replaceable bag filter designed for 862 kPag at 100°C.
 - .3 Filter element performance, 500 micron absolute filter changeable to 5-20 micron nominal.
 - .3 Pot feeder for chemicals:
 - .1 Carbon steel construction.
 - .2 7.6 L capacity.
 - .3 Pressure rated to 862 kPag at 100°C.
 - .4 Propylene glycol to contain inhibitors to minimize corrosion and biologic growth.

3.24 SYSTEM START-UP HYDRONIC SYSTEMS

- .1 Start-up hydronic system in accordance with Section 23 08 02 Cleaning and Start-up of Mechanical Piping Systems.

3.25 BALANCING

- .1 Balance water systems to within plus or minus 5 % of design output.
- .2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.
- .3 Hydronic Systems:
 - .1 Do TAB of the following:
 - .1 New building hydronic heating and cooling system.

- .2 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, pressure drop (or loss), temperature, RPM, electrical power voltage.
- .3 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each heat exchanger (primary and secondary sides), pump, control valve, other equipment causing changes in conditions.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water).

3.26 GLYCOL CHARGING

- .1 Include mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E 202 after cleaning.

3.27 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01 - Performance Verification Mechanical Piping Systems.

3.28 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.29 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by hydronic systems installation.

3.30 STARTUP SCREENS

- .1 Remove and clean following flushing and commissioning.
- .2 Reinstall for normal operation (to be removed in the future by operator).

3.31 COMMISSIONING

- .1 Contractor to provide input into commissioning plan.
- .2 Provide three (3) days written notice to Consultant of intention to start up, test and adjust.
- .3 Review commissioning plan and requirements with Consultant.
- .4 Start up systems only after written approval of installation from Consultant.
- .5 Instrumentation: verify accuracy of thermometers and pressure gauges by comparison with calibrated test instruments.

- .6 Full scale tests: upon completion, conduct full scale tests at maximum design flow rates, operating temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design requirements.
- .7 Reports: in accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: Reports, supplemented as specified herein.
- .8 Training:
 - .1 In accordance with Section 01 91 13 - General Commissioning (Cx)
Requirements: Training of O&M Personnel, supplemented as specified herein.

3.32 IDENTIFICATION

- .1 In accordance with Section 23 05 53.01 - Mechanical Identification, supplemented as specified herein.
- .2 Identify all piping at each energy transfer station and tie-in location with prefabricated pipe markers.
- .3 In addition, identify piping at building entry.

3.33 DEMONSTRATIONS

- .1 Operate at design temperatures, pressures, flow rates for consecutive period of 48 hours to demonstrate compliance with design criteria and design intents.
- .2 Demonstrations also to show completeness of O&M personnel training.

3.34 CERTIFICATES

- .1 Obtain data form for new pressure vessels, including heat exchangers, chillers, boilers, tanks from manufacture and submit data form and fee at own expense to authority having jurisdiction for certificate for pressure vessels.

END OF SECTION