

**SPECIFICATION**  
**of**  
**MECHANICAL WORK**  
**for**  
**2780 East Broadway**  
**Heating System Upgrade**

**for**  
**City of Vancouver**  
**507 West Broadway, Suite 320,**  
**Vancouver, BC V5Z 0B4**

**MECHANICAL CONSULTANT**  
Integral Group  
Suite 180 – 200 Granville Street  
Vancouver, BC V6C 1S4

**PROJECT NO: 150579.000**

**ISSUED FOR TENDER**

**ISSUE DATE:** April 6<sup>th</sup>, 2016

**1. GENERAL**

1. Overview: This scope of work generally includes the following:
  1. Replace existing gas-fired boiler with four new condensing type boilers, complete with flue exhaust, combustion air intake, and individual circulator pumps.
  2. Replace all existing hydronic pumps, and provide new secondary circuit pumps.
  3. Partially drain entire building heating system as required and dispose hydronic fluid to sanitary drain, or as otherwise required by local regulations.
  4. Re-route hydronic piping within the mechanical room to suit upgrades.
  5. Install new boiler condensate pumps and new expansion tank.
  6. Provide new natural gas connection from existing service within mechanical room.
  7. Completely remove existing insulation from hydronic piping within mechanical room. Provide new insulation and finishing for new piping and equipment including the low-loss header. Allow for new pipe identification of new work within mechanical room. Existing domestic cold and hot water services are not part of this contract, and existing insulation on domestic piping is to remain.
  8. Electrical work – Make allowance for connections to new boilers and pumps.
  9. Isolate the existing blower coil unit heating coil serving the Vivo area. Remove the existing blower coil unit including original refrigeration pipework.
  10. Install new blower coil unit including outdoor condenser and new three-way control valve. Connect to existing DDC controls system.
2. Intent: This Specification shall serve to provide direction and standards to enable the Contractor to supply and install a finished, fully functional mechanical system for the project, in complete accordance with current Building Code and Local Bylaws. The Mechanical Contractor shall include all labour, material and equipment necessary to complete the mechanical work.
3. Instructions to Bidders: Mechanical trades bidding demolition work shall attend a site meeting to review existing mechanical services and equipment in demolition and renovated areas. Access will be given to roof and existing mechanical and electrical rooms as required. See invitation to tender (ITT) for date of site visit.
4. Existing Conditions: Protect all existing services encountered. Drawings indicate general locations of existing services. The Contractor shall be responsible for verifying the exact locations of services and conditions on site, prior to fabrication of work. The work shall include the relocation of connection onto existing equipment, piping, ductwork, and existing finishes as indicated. Make good equipment, insulation, piping and ductwork damaged or disturbed during the work to match existing. Identify condemned materials and installations, and notify Consultant.
5. Sequencing: Work shall include all necessary provisions to keep the active building in operation during its respective normal business hours (confirm hours with the Owner's Operations Representative). During business hours, the contractor shall ensure that controls, fire protection, ventilation, exhaust, air conditioning, and plumbing services are maintained outside the area of work. The heating system may be decommissioned during occupied times as warm weather permits. Coordinate times, access, hoarding, scaffolding, tool/light power, and any other miscellaneous items needed to complete with the Owner's Operations Representative. A submission of tender price will serve as confirmation that the contractor has a complete understanding of the scope of work, the related sequencing/schedule requirements, and has included necessary allowances for off-hours work in the tender submission. A proposed schedule of work, including required shut-downs of services and a list of on-site provisions for construction, shall be submitted to the Owner and Consultant for acceptance before commencing work.
6. Demolition and Disposal: In general, include for safe disposal (from site) or recycling of all removed equipment and services. Refer to drawings and subsequent sections for specific instructions for removing or relocating equipment.

Do not re-use any existing mechanical components unless specifically noted otherwise.

7. **Liability:** Assume responsibility for laying out work and for damage caused to the Owner or others by improper execution of work. Protect finished and unfinished work from damage. Take responsibility for condition of materials and equipment supplied, and protect until work is completed and accepted.
8. **Certificates:** Give notices, obtain permits, and pay permit and inspection fees so work specified and shown may be carried out. Furnish certificates, if requested, as evidence that work conforms with laws and regulations of Authorities Having Jurisdiction.
9. **Cutting and Patching:** Measure out and provide locations for holes for mechanical equipment and provide sleeves required for the mechanical installations. Be responsible for cutting and patching of building structure required by work unless otherwise indicated. Provide new roof flashings and/or jacks that are adequately sized and suited for use with the existing roof assembly.
10. **Testing:** Test equipment and materials where required by Authorities Having Jurisdiction, to demonstrate proper operation.
11. **Guarantee:** Provide the Owner with a written guarantee for labour and material warranting systems and equipment furnished to remain in serviceable condition for a period of one year from date of final acceptance by the Owner.
12. **Standard of Materials and Workmanship:** Make and quality of materials used are subject to acceptance by the Consultant. Materials shall be new and of uniform pattern throughout, where specifically identified in this specification. Workmanship shall follow the best tradition and tradesmanship. Employ only tradesmen properly licensed for work requiring tradesmen with special skill.
13. **Access:** Ensure adequate maintenance access is maintained to manual balancing dampers, fire dampers, valves, meters, equipment, including those existing. Provide adequately-sized and fire-rated (where required) access doors where a solid finished ceiling exists.
14. **Slab Penetrations:** Floor penetrations for services must respect restrictions of structural floor slabs and existing in-slab conduit and other in-slab services, and may not penetrate existing concrete slab bands or column caps. Confirm with the Landlord if core holes are required to be verified on site by the Landlord's Structural Engineer. **Contractor are to allow for x-ray scan and coring in their bid.**
15. **Shop Drawings:** Submit copies of shop drawings (for applicable items) for HVAC equipment, BMS/DDC system, pumps, boilers (and all accessories), hydronic specialties, control valves, heat exchanger, chemical treatment system, low-loss header spooling diagram, backflow preventers, fans, air outlets, firestop systems, and fire dampers, to the Consultant for review including all performance data, physical dimensions, electrical data and operating weights.
16. **Record Drawings:** Ensure one set of white print plans and specifications are kept on site at all times for Consultant inspection. Indicate any changes and deviations from the contract documents, including work by change orders and job instructions.
17. **Asbestos Removal or Containment:** Existing wall and ceiling assemblies in mechanical room have drywall mud containing asbestos. Engage a professional asbestos specialist to advise correct procedure for removal, covering, and/or disposal. Make all necessary provisions to protect the indoor air quality and general safety of the existing occupied building, and adhere to all relevant Worksafe BC procedures and requirements.
18. **Additional Documentation:** Contractor shall supply all documentation and information which is required for application to incentive and rebate programs (such as FORTIS BC Efficient Boiler Program).

19. Close-Out Documentation/Operation And Maintenance Manuals: Within two weeks of Substantial Completion: provide three copies of the following (where applicable) in 8-1/2" x 11" plastic coated catalogue binders. One copy of final manuals is to remain with Consultant during warranty period.
1. Project Information
    1. Project Name, Address, and Date of Substantial Completion.
    2. Contact Information for General Contractors and all Mechanical Contractors and Subtrades.
  2. Letters of Assurance and Warranty Documents
    1. Copies of all applicable work permits.
    2. Copy of Contractor's (and Mechanical Sub-Contractor's if applicable) 1-Year Warranty Letter.
    3. Warranty Forms for All Applicable Mechanical Equipment.
    4. Letters of Assurance for Seismic Bracing.
    5. Letter from Firestop Contractor certifying firestop is complete and installed according to Manufacturer's listings.
    6. Plumbing Final Inspection Certificate. (If Required)
    7. Natural Gas Inspection Report. (If Required)
    8. Backflow Preventer Test Certificates.
  3. Testing, Adjusting, and Balancing (TAB) Documentation
    1. Water Balancing Report.
    2. Piping Test Forms
    3. Chemical Treatment Report
    4. Boiler Start-up Form
  4. HVAC System
    1. Brief Description of HVAC System Components and Operation.
    2. Operating and Maintenance Manuals for New Equipment.
    3. Sequences of Operation (Controls Shop Drawings).
  5. Final Shop Drawings.
20. Field Review: The Mechanical Contractor shall notify the Consultant, in writing and within 48 hours, of start-up of work, for 50% completion and 100% completion status for field review scheduling purposes.

## **2. IDENTIFICATION**

1. Provide identification systems for materials used in mechanical systems which require control by Workplace Hazardous Materials Information System (WHMIS) issued by Occupational Safety and Health Division of WorkSafeBC. Provide copy of Safety Data Sheets in Mechanical Maintenance Manuals.
2. Tag automatic controls, electric switches, instruments and relays with lamicoid labels with 1" letters and key with control schematics. Provide lamicoid labels with 1" letters on equipment and motor starters.
3. Provide pipe/ductwork identification and flow direction arrow for every 20 feet of straight run and at every change of direction, at each shutoff valve and adjacent to each piece of equipment. Labels shall be waterproof and heat-resistant with a yellow background, minimum 25 mm lettering and dry adhesive backing. Provide 3M No. 76 Adhesive in addition to dry adhesive backing.

4. All pipe, duct and other systems (DDC) identification shall also be coordinated with the existing identification scheme and Owner's requirements.

### **3. BALANCING**

#### **1. SCOPE**

1. Perform Hydronic Balancing Procedures as described herein for new plant components (boilers, pumps, heat exchanger, control valves) and new blower coil unit heating coil. Air balancing is not required to be part of this contract. Balancing of existing hydronic distribution to radiant heating and VAV zones outside of the main mechanical room are not part of this contract.
2. The Contractor shall arrange cooperation between TAB and Controls Subcontractors to carry out the procedures described in this section.

#### **2. Quality Assurance**

1. Acceptable Balancing Firms: Western Mechanical Services Ltd., BC Group, Precision Air, KD Engineering.
2. Procedures shall be in accordance with current edition of AABC's National Standards for Field Measurement and Instrumentation, Total System Balance.

#### **3. Procedures**

##### **1. General:**

1. Before balancing, submit a summary of proposed methods and instruments to be used to Consultant for review. Provide and include sample forms/sheets to be used in the Balancing Report.
2. Perform balancing at a time when temporary override of the heating system will not affect building occupants.
3. Permanently mark setting on valves, splitters, dampers and other adjustment devices. Take measurements to verify balance has not been disrupted or such disruption has been rectified.
4. At final field review, re-check random selections of data recorded in report. Recheck points or areas as selected and witnessed by Consultant and/or Owner.

##### **2. Preparation of System – Hydronic System shall be prepared for balancing by Mechanical Contractor in the following manner:**

1. Open valves. Close bypass valves.
2. Determine water in system has been treated and is clean.
3. Check pump rotation.
4. Confirm expansion tanks are not air bound and system is full of water.
5. Confirm air vents at high points are installed properly and are operating freely and air is removed from circulating system.
6. Set temperature controls for full flow, using DDC as necessary.
7. Check operation of automatic control valves.
8. Check and set operating temperature of equipment to design requirements.

##### **3. P-1, P-2, and P-3**

1. The existing pumps are being replaced with identical new pumps. Circuit balancing valves are to be used to balance these parallel duty-standby pumps relative to each other only. Do not use to adjust overall flow. The circuit balancing valves should be left as wide open as possible.
2. Once the pumps have been commissioned, the following readings are to be taken concurrently:

- Total flow (L/s)
- Supply water temperature (°C)
- Return water temperature (°C)
- Differential pressure across pumps (kPa)
- Outdoor air temperature (°C)
- Date and time measurements were taken

4. P-B1, P-B2, P-B3, P-B4

1. Balance these constant-speed pumps to achieve the specified flow for the boiler they serve (respectively). Use pump speed selector for rough balancing with circuit balancing valve wide open. Adjust circuit balancing valve for fine-tuning adjustment only. Record differential pressure across pumps as read by gauges.

5. P-4 and P-5

1. No balancing is required for these pumps.

4. Acceptance: Mechanical systems shall not be considered ready for final field review until balancing results are acceptable to Consultant. If found that specified flows cannot be achieved on portions of system, actual conditions shall be reported to Consultant for consideration of corrective action before continuing balancing procedure. If report rejected, systems shall be re-balanced and new certified report submitted at no additional cost to the contract.

5. Balancing Report

1. Submit draft copies of reports, complete with field notes, before final acceptance of project. Provide copies of final report for inclusion in Operating and Maintenance Manuals.
2. Include types, serial numbers and dates of calibration of instruments.
3. Report shall be indexed as follows:

Section 1	Instrumentation and Measurement Procedures
Section 2	System Data (Designed, Installed and Recorded) <ul style="list-style-type: none"><li>• Air Heating and Cooling Equipment (Terminal Units, Coils)</li><li>• Water Moving Equipment (Pumps)</li><li>• Water Heating and Cooling Equipment (Chillers, Boilers, Heat Exchangers)</li></ul>
Section 3	Drawings <ul style="list-style-type: none"><li>• Balancing Drawings</li><li>• Equipment Shop Drawings</li></ul>
Section 4	Discussion of Results
Section 5	Warranty and Certification

**4. TESTING**

1. Test equipment and material where specified or required by Authority Having Jurisdiction. Test in accordance with applicable portions of ASME, ASHRAE, BCBC, SMACNA, NFPA, CSA and other recognized test codes.
2. Provide notice of tests to Consultant. On completion of installation, provide certification of tests with required detail. Itemize tests as to time performed and personnel responsible. Include copy of field data in Operating and Maintenance Manuals.

3. Pressure Tests

1. Piping, fixtures or equipment shall not be concealed until inspected and approved by Consultant. Carry out hydraulic tests for 8 hours. Maintain pressure. Where leakage occurs, repair and re-test.
2. Domestic Water Piping: Test to 1-1/2 times maximum working pressure or 1035kPa (150 psi) water pressure

measured at system low point.

3. Drainage System: Test by filling with water to produce water pressure of 2.5 m water column minimum and 12m water column maximum. Check for proper grade and obstruction by ball test.
4. Natural Gas Piping: Test as required by Authority Having Jurisdiction.
5. Low Pressure Ducts: Test for tightness such that leakage is inaudible and not detectable by feel.
6. Should tests indicate defective work or variance with specified requirements, correct defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints and re-making joints in copper lines. Do not caulk.

4. Performance Tests

1. Lubricate bearings, adjust and/or replace and set direct and "V"-belt drives for proper alignment and tension.
2. Calibrate and adjust thermostats, linkages and dampers. Operate and test motors for correct wiring and sequences. Check overload heaters in motor starters. Fasten loose and rattling pieces of equipment to ensure quiet operation.
3. Gas-fired appliances shall be subjected to operational testing established by the Gas Safety Branch and pass these tests before being approved for operation.

5. **VIBRATION ISOLATION AND SEISMIC RESTRAINT**

1. Provide vibration isolators and seismic restraint systems meeting requirements of Authority Having Jurisdiction and Commentary J, Effects of Earthquakes, in Supplement to National Building Code of Canada with regard to seismic forces transmitted to piping/equipment from building structure during an earthquake at project location. Provide sealed and signed engineered details and Letters of Assurance by Seismic Engineer licensed in British Columbia. Final seismic inspection and Schedule CB to be completed prior to Substantial Performance, and copied to the Consultant.
2. Seismic restraint for sprinkler systems shall conform to NFPA 13 and requirements of local authorities.
3. Provide aircraft cable and fastening materials capable of restraining 1.5 times calculated seismic forces transmitted through equipment or piping restrained.
4. For suspended equipment where sway will exceed 100 mm, slack cable restraints shall be connected from each support point (minimum four) to structure at angle of 45° in elevation and at 90° to each other in plan view. Provide minimum two steel band straps above centre of gravity on vertical tanks anchored to structure. Straps, anchor bolts and straps shall be capable of withstanding seismic forces in all directions. Where top of individually suspended pipe or duct is less than 300mm below supporting structure, transverse and longitudinal bracing shall not be required.
5. Provide transverse and longitudinal seismic restraint on nominally horizontal piping as follows:

Service	Sizes Where Required	Longitudinal Restraint Spacing	Transverse Restraint Spacing
Natural Gas Piping	25ø and larger	12m on centre	6m on centre
All Other Services	63ø and larger	24m on centre	12m on centre
Rectangular Ductwork larger	0.55m <sup>2</sup> area and larger	24m on centre	12m on centre
Circular Ductwork and larger	712ø diameter	24m on centre	12m on centre

6. Branch lines shall not be used to restrain main piping. Where nominally horizontal length of pipe or duct exceeds the maximum allowable transverse restraint spacing listed in the Restraint Installation Schedule, a minimum of one

longitudinal and one transverse restraint shall be provided.

7. Where horizontal pipe or duct passes through vertical concrete or concrete block wall within sleeve, wall will be considered transverse restraint point. Cables shall be tightened to remove slack (25 mm deflection under thumb pressure), but shall not support any weight under normal operating conditions. Allowances shall be made for normal expansion and contraction of piping systems where applicable.
8. Support weight of vertical pipe in open shafts at point above its centre of gravity where possible. Provide lateral guides at top and bottom of riser and at intermediate points not exceeding 30'-0" on centre.
9. For new pumps P-1 and P-2, provide rubber/neoprene-in-shear isolators designed to meet specified seismic requirements. Select for 4.0 mm minimum static deflection and bolt to structure. If piping up- and down-stream of pumps is grooved, provide flexible Victaulic grooved couplings in number and orientation advised by the manufacturer for vibration attenuation (do not use "Zero Flex" style rigid couplings throughout). For rigidly connected piping, provide Mason SafeFlex connectors on pumps.
10. For all other new motor-driven equipment, provide vibration isolation grommets at support points.
11. Provide neoprene isolators and components using maximum 60 duro "Bridge bearing quality neoprene," as defined by CSA Standard CAN3-S6-M78. Ensure design of isolation and restraint elements allows adequate clearance to avoid binding.

## **6. FIRESTOPPING**

1. Work Included: Contractors are to repair, patch, and firestop any penetrations through walls. Furnish labour, material, equipment and services necessary to provide firestopping and smoke seals around mechanical service piping and duct penetrations through fire and/or smoke rated wall and floor assemblies to CSA standard CAN4-S115-M85 and Authorities Having Jurisdiction.
2. Work shall be carried out by approved specialist firm, employing tradesmen experienced in firestopping and smoke seal application. Installing Contractors shall be certified by the British Columbia Insulation Contractors Association for work specified. Work shall be installed in accordance with Manufacturer's recommended installation procedures.
3. Acceptable Firestopping Systems Manufacturers: 3M, Hilti, Bio-Fire.
4. At project completion, provide letter certifying that firestop is complete and installed according the Manufacturer's listings and final shop drawings.

## **7. INSULATION**

1. Insulation thicknesses and performance shall conform to requirements of ASHRAE Standard 90.1-2010 (Table 6.8.2 Minimum Duct Insulation, Table 6.8.3 Minimum Pipe Insulation Thickness).
2. British Columbia Insulation Contractors Association (BCICA) Standards Manual, Latest Edition, shall form part of this specification of mechanical insulation. Copy of current standard shall be available at site.
3. Materials and application temperatures shall be as recommended by adhesive, coating or sealer manufacturer. Make good separations of joints or cracking or insulation due to thermal movement or poor workmanship. Composite fire and smoke hazard ratings for adhesives, insulation, coatings and jackets shall not exceed 25 for flame spread and 50 for smoke developed or otherwise as required by Code. Use only ULC listed or tested recovering materials.
4. Piping

1. Insulation Thickness Schedule:



<u>Piping to Be Insulated</u>	<u>Insulation Thickness</u>
Domestic Cold Water	25 mm
HWS/HWR	per ASHRAE 90.1-2010 Table 6.8.3

2. Finishes: to BCICA Standard "PF2 Premium 2" (or 15 mil PVC jacket with solvent welds).
3. All "cold" services including domestic cold water, irrigation, and chilled water piping shall use oversized pipe hangers to permit continuous insulation and vapour barrier to be maintained.
5. Do not install coverings before piping and equipment have been tested and approved. Ensure surface is clean and dry and that systems are operating at design conditions before installation.
6. Finish insulation neatly at hangers, supports and other protrusions. Insulate fittings and valves. For exposed application finish, ends of insulation shall be neatly trowelled on bevel. For hot water piping, do not insulate unions, flanges, and flexible connections.

## 8. **PLUMBING**

1. Provide all necessary piping material and labour for the systems as shown on the drawings. Piping and fittings shall be in accordance with current edition or applicable revisions of applicable codes or governing regulations.

### 2. Pipe and Fittings

<u>SIZE</u>	<u>PIPE</u>	<u>FITTINGS</u>
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#### Sanitary Drainage and Vent

##### Piping Above Grade:

Up to 63ø	DWV Copper	Wrought or cast brass with 50-50 solder
75ø and up	Cast Iron	Cast Iron

#### Domestic Water Piping

##### Above Grade

All Sizes	Certified Type "L" or Type "K" hard copper	Wrought bronze or cast brass Silvabrite 100 lead free solder
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#### Natural Gas Piping

All sizes	Sch 40 black steel	Malleable screwed or butt welded joints.
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*Piping over 50ø inside building shall be welded. Buried pipe shall be yellow jacketed with cathodic protection.*

#### Boiler Vent Condensate

All sizes	System 15 DWV PVC (Material must be corrosion resistant; Galvanized or copper-containing materials are not permitted)	
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3. Pipe Supports: All "cold" services including domestic cold water, irrigation, and chilled water piping shall use oversized pipe hangers to permit continuous insulation and vapour barrier to be maintained. Provide rigid insulation blocking and metal insulation shield between pipe and hanger or riser clamp.
4. Valves
  1. Provide valves of same manufacturer throughout where possible. Valves on cold, hot and recirculation service shall be rated at 125 psi.
  2. Back Flow Preventer Assemblies: Provide ULC listed backflow preventers as shown per drawings and/or as required by the local Authorities Having Jurisdiction.

3. Potable Water System Pressure Reducing Valve: Provide pilot operated globe type pressure reducing valve with bronze strainer assembly to limit static water pressure to 100 kPa (15 psi) on incoming water line to Plumbing Code requirements. PRV shall be WATTS Model PV-10M with Y-strainer to sizes indicated with U5B in parallel.

5. Execution

1. No pipe shall be installed in any part of wall where temperature is less than 5°C under winter design conditions.
2. Grade drainage lines minimum 2%, piping 100" and larger may be graded at minimum 1% slope. Plug or cap pipe and fittings to keep out debris during construction.
3. Wherever dissimilar metals are joined or supported, piping shall have non-conducting type connections or hangers to prevent galvanic corrosion. Brass adapters and valves are acceptable for pipe connections.
4. Water Specialties: Provide back flow preventers as specified and as required by Authorities. Provide trap primers to all floor drains.
5. Thoroughly flush water piping until free from scale, sediment and debris as soon as possible after system filled with water. Refer to Specification requirements for HVAC water treatment.

9. **BLOWER COIL UNIT**

1. Standard of Acceptance: Trane, Lennox
2. Indoor Unit:
  1. Cabinet:
    1. Steel frame and sheet metal cabinet housing fan, coil, drain pan, filters and controls.
    2. Cabinet line with ½" (12 mm) thick acoustic insulation.
    3. Access to components.
    4. Condensate drain pan.
  2. Fan:
    1. Fan with adjustable belt speed drive.
  3. Coil:
    1. Aluminum fins bonded to seamless copper tubes.
  4. Refrigerant Circuits:
    1. Refrigerant circuits controlled by factory installed thermal expansion valves.
  5. Filters:
    1. 1" (25 mm) thick replaceable media, equal to MERV-8 minimum efficiency.
  6. Control:
    1. Low voltage terminal board and fan contactor.
  7. Accessories
    1. Hydronic heating coil as scheduled.
3. Outdoor Condensing Unit:
  1. Casing:
    1. Heavy welded steel frame and galvanized steel panels, baked enamel finish.
    2. Removable access panels.
  2. Compressors:
    1. Hermetic reciprocating compressors with internal spring isolation.
    2. Centrifugal oil pump.

3. Crankcase heater.
3. Refrigerant Circuit:
  1. Liquid line filter drier(s).
  2. Liquid line service valve(s) with gauge port.
  3. Suction line service valve(s) with gauge port.
4. Condenser:
  1. Direct drive propeller fans, vertical discharge.
  2. Fan safety guards.
  3. Condenser coil with aluminum fins bonded to copper tubes.
5. Controls:
  1. Factory wired in separate enclosure.
  2. 24 V control circuit, control power transformer.
  3. Magnetic contactors.
  4. Overload devices for compressor(s) and fan(s).
  5. Anti-short cycle timer.
4. Refrigeration Compressors:
  1. Compressor shall be high performance rotary type and optimised for R41-0A.
  2. Units shall be equipped with high pressure cut-off with manual reset.
  3. Mounted enclosed panel shall include:
    6. Suction and discharge refrigerant pressure gauge tappings.
    7. High and low pressure cut out.
    8. Low ambient kit for operation to 0°F (-18°C).
    9. Time delays to prevent cycling of compressor on low loads, crank case heater.
5. Refrigerant Piping and Accessories:
  1. Refrigerant grade angle, globe and ball shut-off valves.
  2. Pressure gauge taps at compressor inlet and outlet and other locations required.
  3. Staged oil traps where evaporator is below compressor.
  4. Reversing valves and control circuitry.

## **10. HYDRONIC HEATING SYSTEM**

1. Provide complete heating systems to meet applicable code requirements and in compliance with ASME/ANSI B31.9 ASME code for pressure piping.
2. Follow ASHRAE standards for pipe, fittings, balancing and adjustment.
3. Welding materials and labour shall conform to ASME code and provincial regulations. Use welders qualified and licensed by provincial authorities. Take very precaution to prevent fires.
4. General Standards
  1. Steel pipe - ASTM A53, Grade A, CSA B63.
  2. Copper tube - ASTM B88, CSA HC 7.6.
  3. Copper pipe - ASTM B42, CSA HC 7.5.
  4. Steel welding fittings - ASTM A-234, standard weight.
  5. Flanges - ASTM A-131, GR-1.

6. Malleable iron fittings - ASTM A47-68 and/or A-197.
7. Mechanical joint gaskets - moulded synthetic rubber for 200°C continuous operation (intermittent service to 250°C) - ASTM D-735-61, Grade R615 bz.
8. Fittings for copper piping - ANSI B-16.

5. Pipe and Fittings

1. Service	Pipe	Fittings
<u>Heating Water</u>		
Schedule 40 Steel	Malleable iron or steel	Victaulic grooved mechanical couplings or threaded fittings
Type "M" hard copper	Wrought copper or cast bronze	95-5 solder or brazed

2. Use long radius elbows and factory fabricated butt weld fittings for welded steel pipes.
3. Pipe up to 65 mm shall be stretched reduce continuous weld steel and ERW for larger sizes.
4. Victaulic gaskets shall be EPDM rated for maximum 110°C on heating systems.

6. Hangers and Supports for Piping and Equipment

1. General

1. Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction and accommodate insulation.
2. Provide insulation protection saddles on insulated piping.
3. Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.
4. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.
5. Do not suspend from existing supports or equipment.
6. Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).

2. Pipe Attachments:

1. Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm; hot steel piping with middle attachment (rod) 300 mm or less pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181 up to NPS 6 and Grinnell/Anvil fig. 171 NPS 8 and larger.
2. Bottom supported hot piping, steel and copper: pipe roller stand - Grinnell/Anvil fig. 271.

3. Riser Clamps

1. Steel or cast-iron pipe: galvanized carbon steel - Grinnell Anvil fig. 261 or Myatt fig. 182.
2. Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121.
3. Acceptable Product for isolated riser clamp: Holdrite #273 with 10 ga bearing plates and pads.

4. Saddles and Shields

1. Hot piping NPS 3 and under: insulation over pipe hanger.
2. Hot piping NPS 4 and over: protective saddle with insulation under saddle - Grinnell/Anvil fig. 160 to 166.

5. Wall Supports

1. Horizontal pipe adjacent to wall: Angle iron wall brackets with specific hangers, Holdrite #255, #261, #280,

#285.

2. Vertical pipe adjacent to wall: Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263, or Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut (arrangement to be acceptable to BC Boiler Inspection Department).

6. Spacing: According to the table below:

Pipe Size NPS	Rod Dia.	Max Spacing	
		Steel Pipe	Copper Pipe
12" (1/2")	9.5mm	1.8m	1.5m
¾, 1	9.5mm	2.4m	1.8m
1 ¼, 1 ½	9.5mm	3.0m	1.8m
2	9.5mm	3.0m	3.0m
2 ½, 3, 4	12mm	3.0m	3.0m

7. Unions And Flanges: Rated At 1,035 kPa At 100°C

8. Valves

1. Valves on hot water heating and condensing water service, rated at 1,035 kPa at 100°C (rising stem or ball valves). Chilled water valves shall be rising stem design.
2. Gate valves to 50 mm: bronze, non-rising stem, inside screw, double wedge or disc, solder or screwed ends. Red & White/Toyo Fig. 293.
3. Gate valves, 65 mm and up: iron body, bronze trim, rising stem OS&Y, solid wedge, flanged ends. Red & White/Toyo Fig. 421a.
4. Globe or angle valves to 50 mm: bronze, rising stem, inside screw, renewable composition disc, screwed or solder ends. Red & White/Toyo Fig. 214.
5. Globe or angle valves, 65 mm and up: iron body, bronze trim, rising stem, OS&Y, renewable composition or bronze bevel disc, flanged ends. Red & White/Toyo Fig. 400a.
6. Ball valves to 75 mm: forged brass or cast bronze body, cap, stem and ball with ball hard chromium plated with teflon seat and thrust bearing and bunA-n o ring. Red & White/Toyo Fig. 5044a or 5049a.
7. Check valves to 50 mm -- horizontal: bronze body, bronze trim, swing disc, renewable disc seat, screwed ends. Red & White/Toyo Fig. 236. Vertical: bronze body, bronze trim, lift check, renewable composition disc, screwed ends. Red & White/Toyo Fig. 231.
8. Check valves, 65 mm and up -- horizontal: flanged cast iron body, bronze swing disc and trim. Red & White/Toyo Fig. 435a. Vertical: wafer style cast iron body, viton "a" body seat, 316 stainless steel clapper seat, arm, pin and spring, pft thrust washer. Moyes & grooves Fig. W12A-i6v.
9. Plug cock: iron body, brass plug and washers, air tested.
10. Radiator valves: bronze, rising stem, inside screw, renewable composition disc, angle or globe type, threaded or union ends, back seated up to and including 32 mm, angle or straightaway pattern as required. Red & White/Toyo Fig. 252 or Fig. 253.
11. Circuit balancing to 50 mm: globe style, threaded connections, metal parts pressure die cast metal copper alloy, connections with positive shutoffs for differential pressure meter connection. Valve shall provide flow measurement, flow balancing, positive shutoff with teflon seat and drain connection with cap. Valve handle shall provide digital readout allowing setting to be visible from floor. Test ports shall be easily accessible. Four turns open to closed with tamper-proof memory stop and removable handle. Tour and anderson stad.

12. Circuit balancing 65 mm to 150 mm: globe style, flanged connections, metal parts pressure die cast metal copper alloy, connections with positive shutoffs for differential pressure meter, providing flow measurement, flow balancing and positive shutoff with teflon seat. Valve handle shall provide digital readout allowing setting to be visible from floor. Test ports shall be easily accessible. Eight turns open to closed with tamper-proof memory stop and removable handle. Tour and anderson stad.
13. Composition discs of material suitable for service.
14. Valves shall be by one manufacturer and have name and pressure rating marked on body.
15. Thread pipe sizes 50 mm and smaller and flange pipe sizes 65 mm and larger. Solder or screw to solder adaptors for copper tubing. Use grooved body valves with mechanical grooved joint pipe.
16. Butterfly and/or ball valves may be used for gate or globe valve service. Butterfly valves replacing globe valves shall have gear type operator with memory stop. Ball valves replacing globe valves shall have memory stop.
17. Provide chain-operated sheaves on valves sized 100 mm and larger located more than 2.4 m from floor.
18. Where operating pressure exceeds 1,035 kPa (150 PSI) provide valves rated to 1.5 times service pressures.

9. Hot Water Specialties

1. Automatic air vent: float operated type with isolating valve, brass or semi-steel body, copper float, stainless steel valve and valve seat suitable for system operating temperature and pressure. Automatic washer type shall be brass with hydroscopic fibre discs, vent ports, adjustable cap for manual shutoff and integral spring loaded ball check valve to prevent water leakage.
2. Air separators: centrifugal type with galvanized steel 4.8 mm perforated strainer, perforated stainless steel air collector and drain connections. Acceptable manufacturers: Caleffi, Taco, Watts
3. Relief valves: ASME rated direct spring loaded, lever-operated type, non-adjustable with factory set pressure as required.

10. Expansion Tanks

1. Constructed to ASME code and to comply with provincial government requirements.
2. Acceptable manufacturers: Amtrol, Armstrong, Watts
3. Bladder type of carbon steel rated for working pressure of 860 kPa (125 PSI), prime coated with heavy-duty replaceable rubber bladder and lifting ring.
4. Provide 40 mm system connection, 20 mm drain valve, automotive type charging valve

11. Pumps

1. General:
  1. Acceptable Manufacturers: Grundfos, TACO, Armstrong, Hartell (condensate pump only)
  2. Pumps shall have statically and dynamically balanced rotating parts. Construct to permit servicing without breaking piping. Pump connections shall be flanged.
  3. Pumps shall be appropriate for the working fluid type, working pressure, and normal working temperatures of 15°C (60°F) to 93°C (200°F), as endorsed by the equipment manufacturer.
  4. Pump and motor form an integral unit without shaft seal with only two gaskets for sealing
  5. The motor shall be cooled by the pumped fluid and shall be self-ventilating. The stator housing shall have drain holes to enable condensed water to escape.
  6. Install pumps horizontally per manufacturer's recommendations.
  7. Pump Housing: Bronze or cast iron rated at 860 kPa and 100°C

8. Impeller: bronze, cadmium plated steel, or stainless steel
2. P-B1 through P-B4: Inline Wet Rotor Pipe Mounted Pumps with Integrated 3-Step Manual Speed Controller
  1. Pumps shall have 3 operating speeds with distinct performance curves and manual switching without disassembly or changing of parts
  2. The pump is to be connected directly to an asynchronous squirrel cage design motor and had to have been tested with the pump as one unit by the same manufacturer
12. Boilers - High Efficiency Condensing
  1. Minimum requirements:
    1. Acceptable manufacturers: Viessmann.
    2. Provide forced draft gas fired hot water boiler with insulated jacket, controls and boiler trim. Equipment shall meet all relevant CSA and CGA requirements, and shall be complete with Canadian crn numbers.
    3. Minimum steady state combustion efficiency of 91%, verified by ANSI Z21.13 based on return water temperature of 54°C (130°F).
    4. Certified with eco logo from Environment Canada.
    5. Prequalified for Fortis BC, Efficient Boiler Program.
    6. Complete with manufacturer's supplied controller to allow lead-lag functionality and sequencing.
  2. Construction:
    1. Assembly conforms to ASME code requirements and test for maximum working pressure of 1035 kPa (150 PSI) water.
    2. Flue passages shall be inox-crossal heat exchanger surface of 316 TI stainless steel and readily accessible without special tools.
    3. Structural steel base with front plate, removable panels and lifting lugs. Provide secure attachment points for seismic anchoring.
    4. Entire boiler insulated with 100mm thick glass fibre and finished with steel jacket finished with factory applied baked enamel.
    5. Provide manhole access into boiler as required.
  3. Hot Water Boiler Trim:
    1. Combination water pressure and temperature gauge, and ASME rated pressure relief valves.
    2. Low water cut-off with manual reset and special retard circuit to automatically prevent burner operation when boiler water falls below safe level. Low water cut-off must automatically reset on resumption of power at device.
    3. Electronic operating temperature controller shall control burner operation to maintain boiler water temperature.
    4. Limit temperature controller shall control burner to prevent boiler water temperature from exceeding safe system temperature.
    5. Provide boiler air vent tapping.
    6. Provide one new neutralization tank to receive vent condensation from each boiler. Neutralization tank shall be manufactured by, or endorsed by, the boiler manufacturer. Provide new limestone chip neutralization media (min 85% calcium carbonate content) at time of turnover, in addition to one spare media fill left on-site.
  4. Burner:
    1. Burner operation shall be modulating with low fire position for ignition.

2. Forced draft gas burner with electric ignition, cast aluminum, hinged monobloc design equipped with low-nox burner technology and gas pressure regulator.
3. Pre-wired, factory assembled electronic controls on control cabinet with flame scanner or detector, programming control, relays and switches. Provide pre-purge and post-purge ignition and shut-down of burner in event of ignition pilot and main flame failure with manual reset.
5. Flue and Combustion Air Venting:
  1. Single wall venting system certified for use with Category IV appliances.
  2. Route vents to existing roof openings as indicated on plans. Provide new, watertight, sheet metal flashings for vents and seal to existing curbs and/or roof jacks. Ensure new flashing overlaps existing roof membrane.

**13. HVAC Water Treatment**

1. General: Provide for cleaning and degreasing of new equipment and piping that use glycol or water as heat transfer medium. Include temporary strainers, connections and by-pass lines as required. Existing systems are not required to be chemically cleaned, but must be protected from corrosion during work. Engage a Water Treatment Specialist to provide HVAC water treatment in accordance with ASME Boiler Code Section VII, the requirements specified herein, and any requirements and standards of local regulating authorities.
2. Acceptable Water Treatment Firms: PACE Chemicals, IPAC Chemicals
3. Submittals: Submit shop drawings including proposed chemicals, quantities, procedures and equipment to be supplied. Provide written operating instructions and system schematics including MSDS data and safe disposal instructions. Provide samples of testing record sheets with recommended water treatment testing schedule for the proposed treatment. At completion of project, provide written report containing log and procedure of system cleaning, giving times, dates, problems encountered and condition of water.
4. Water Treatment Specialist: Water treatment chemicals and treatment process shall be supplied and performed as part of this contract. Engage a Water Treatment Specialist to supervise activities and provide chemicals, feed systems and test equipment. Upon completion, the specialist firm shall certify process is satisfactory and submit report outlining cleaning operation and treatment process. Contractor shall provide name and supplier of chemical treatment specialist as part of post tender submittals and progress claim breakdown.
5. Procedures - Cleaning: Chemically clean and degrease new equipment and piping installed as part of this contract, as recommend by the water treatment specialist. System Cleaner: Sodium Metasilicate, Sodium Nitrite or acceptable equal and wetting agent compound, which in solution removes grease and petroleum products. Concentration level to be determined by Water Treatment Specialist.
6. Procedures - Treatment: Provide complete start-up and commissioning, including the amounts of chemicals and filter media change-outs sufficient to calibrate the system.
7. Products: Treatment chemicals shall not contain hydrazine, and shall be non-foaming.
  1. Water System Chemicals: Borated Nitrite-Molybdate based corrosion inhibitor. Maintain levels at 200 to 400 ppm (PACE Chemicals Ltd. – BAR COR CWS-91 or approved equal). The use of Nitrite only, Molybdate only or Sulphite only will not be accepted.
8. Chemical Feed System Equipment:
  1. Bypass Pot Feeder: Closed water systems shall have by-pass chemical pot feeder with 7.6 L capacity, constructed of heavy-duty cast-iron or welded steel (suitable for 1,380 kPa working pressure), with quick opening cap and complete with NPS 3/4 connections. Install isolating valves on inlet, outlet and drain.
  2. Side Stream Filters: Closed systems shall have side stream filters. 304 L stainless steel or propylene plastic filter housing to accept 30 micron – 65 mm x 1.0 m long filter cartridges and complete with swing bolt lid. Minimum flow rate of 35 L/min. A Flow Indicator with stainless steel impeller shall be installed as per Manufacturer's instructions. Include 10 filter replacement cartridges for each side stream filter unit.
  3. Chemical Feed Piping shall be Schedule 40 black steel.



4. Provide make-up water meter equal to Neptune T-10, Neptune Trident 8 or Rickwell Hersey complete with electronic pulse output for flow monitoring by building automation system. Water meter shall be provided by the controls subcontractor, and installed by the mechanical contractor.
5. Corrosion Coupon and Holder Assembly: Mild steel and copper corrosion coupons. Holder: NPS 3/4 or NPS 1 connection. Provide malleable or cast-iron cross, NPS 3/4 or NPS 1 connection.
9. System Turnover and Guarantee:  

Water Treatment Specialist shall instruct maintenance personnel before substantial completion. Written instructions of treatment, dosages, control charts and test procedures shall be included in maintenance manuals. Water Treatment Specialist shall provide monthly visits to check chemical treatment, take water samples and recommend any changes to treatment, and provide written report for period of one year after substantial completion. Provide a stock of chemicals, filters and corrosion coupons suitable for 12 months normal operation or minimum (5,000) hours of operation for system volume (minimum one spare pail 20 L of chemicals for each closed system requiring treatment). Provide test kit suitable for chemical treatments used. Test kit shall be made available for on-site tests and provide Myron 3 range TDS meter to check conductivity. Hand kit over to Building Operator at project completion; obtain receipt.

## **11. CONTROLS**

1. Provide a complete system of automatic controls as required, including line and low voltage control wiring. Provide all components and coordinate with the electrical trade for power connections. All control wiring including line and low voltage wiring to/from control devices and terminal equipment. Control interlocks shall be provided by the Controls Subcontractor.
2. Controls Subcontractor shall be a manufacturer-certified installer for Delta (Telephone ESC Automation for City of Vancouver Account Representative). New controls shall be fully integrated with City of Vancouver's existing server and graphics.
3. All new equipment shall be compatible with **ESC Delta** where possible, and have manufacturer's warranty and factory support from ESC where applicable.
4. Control Valves:
  1. Acceptable Manufacturers: Belimo.
  2. Shall be supplied by the controls subcontractor and installed by the mechanical contractor.
5. Controls Subcontractor to submit control shop drawings, including final sequences of operations, hardware components, wiring diagrams, and sample graphics to Consultant for review prior to installation.
6. Controls Subcontractor to participate in balancing procedures with TAB Subcontractor. Refer to Balancing Procedures in sections above.
7. Refer to separate section "Sequence of Operation" attached to this specification.

## **12. FIRE PROTECTION**

1. Existing building is equipped with hose cabinets and extinguishers only. No fire protection work is required as part of this contract.

**SEQUENCE OF OPERATION**

1. Boilers B-1, B-2, B-3, and B-4
  1. The heating water system shall be enabled whenever the B.A.S. detects an outside air temperature of 17°C (59°F) or less.
2. Boiler B-1, B-2, B-3, and B-4 shall all operate in lead - lag mode and alternate monthly as directed by the boiler controller.
  1. On call for heating from a boiler, that boiler's circulator pump shall be enabled to maintain continuous flow through the boiler.
  2. Heating water system supply temperature setpoint is reset based on building load and outside air temperature, and modulated via 0-10V signal to boiler controller.
  3. Heating water supply setpoint modulates between 38°C (100°F) to a maximum of 82°C (185°F) to satisfy building heating demand. DDC input shall change setpoint no faster than 2°C per minute.
  4. When the lead boiler cannot maintain heating water supply setpoint, the lag boiler shall stage on and run in unison with the lead boiler. As heating water temperature rises back above setpoint, the lag boiler shall stage off.
  5. When the lead boiler is in alarm, the lag boiler shall stage on and run in unison with the lead boiler if required to maintain supply water temperature setpoint. Once the alarm has been cleared the lag boiler shall stage off.
  6. On failure of the lead boiler, the standby boiler shall run and the lead boiler shall turn off. Once the alarm has been manually cleared the lag boiler shall stage off and normal operation restored.
  7. The boilers shall run subject to their own internal safeties and controls. All boiler trips caused by internal safeties shall send a general alarm to the B.A.S.
3. Pumps
  1. There are a total of 8 pumps on the system. Pump identification and duties are as follows:
    1. P-B1, P-B2, P-B3, and P-B4 are primary boiler circulator pumps and controlled for each boiler.
    2. P-1, P-2, and P-3: Are the secondary circulator pumps and enabled when there is a call for heat.
    3. P-4: Is the boiler condensate pump operating in standalone configuration with it's built-in controller.
  2. Pumps P-1, P-2, and P-3 shall operate in lead - lag mode and alternate monthly.
  3. Pump P-4 shall be operate via its built-in controller.
4. BCU-1
  1. When the blower coil unit supply air temperate drops below setpoint, heating water shall circulate through the coil.
  2. Control valve CV-1 modulates to maintain the supply air temperature setpoint as determined by the B.A.S. The default setpoint value shall be 20°C (68°F).
  3. Any time outside air temperature drops below -10°C (14°F), CV-1 goes to 100% open to ensure flow through heating coil. This operation shall occur in both occupied and unoccupied schedules to prevent damage due to coil freezing.
  4. When there is a call for cooling from the Vivo space temperature sensor, the heating control sequence shall be overridden and CV-1 goes to 0% closed to ensure heating flow fully bypasses the coil.

5. When there is a call for cooling from the Vivo space temperature sensor, the rooftop condensing unit shall energize to maintain a supply air temperature of 12°C. The rooftop condensing unit shall cycle on/off to maintain supply temperature setpoint.

5. Hydronic System Pressure Control

1. Expansion tank ET-1 combined with the make-up water connection automatically maintains heating water system pressure. The B.A.S. monitors system pressure via expansion tank pressure sensor and make-up water flow switch.

6. Alarms

1. The B.A.S. shall monitor heating water system supply and return water temperatures and initiate a general alarm if:
  1. Heating water supply is greater than 94°C (200°F).
  2. Heating water supply is less than 38°C (100°F).
  3. Heating water return is greater than 72°C (162°F).
2. The B.A.S. shall monitor the following boiler safeties and issue a general alarm for:
  1. All boiler controller alarms.
  2. Low water level alarm.
  3. Failure: commanded on but the status is off.
  4. Running in hand: commanded off but the status is on.
  5. Runtime exceeded: status runtime exceeds (user defined limit).
  6. Low water level alarm.
3. The B.A.S. shall monitor pumps and issue a general alarm for:
  1. P-1, P-2, or P-3 controller alarms.
  2. Boiler pump failure: commanded on but the status is off.
  3. Boiler pump running in hand: commanded off but the status is on.
  4. Boiler runtime exceeded: status runtime exceeds (user defined limit)
  5. All boiler controller alarms.
4. The B.A.S. shall monitor expansion tanks and issue a general alarm if:
  1. System pressure is greater than boiler relief valve setting confirmed during system commissioning.
  2. System pressure is less than static pressure confirmed during system commissioning.
5. The B.A.S. shall monitor make-up water station and issue a general alarm when fill water flow is detected.

7. Proof Points

1. Pump status to be monitored by B.A.S. using current sensors. B.A.S. graphics to display pump current in amps as proof of operation.
2. Secondary hydronic system status shall be monitored by the B.A.S. using a return water temperature sensor located in the main mechanical room. B.A.S. graphics shall display return water temperature for this portion of the system as proof of operation.

8. Failure Modes

1. Automatic failure modes for equipment controlled by DDC shall be as follows:
  1. Boilers B-1 through B-4: fails ON. On loss of 0-10V signal from DDC, boiler on-board controls shall default to maintain a system supply water temperature of 82°C (180°F)
  2. Boiler Circulation Pumps P-B1 through P-B4: fail ON
  3. Main Circulation Pump P-1: fail ON
  4. Main Circulation Pump P-2: fail ON
  5. Main Circulation Pump P-3: fail ON
  6. BCU Heating Control Valves CV-1: fail full flow to coil ("A" open, "B" closed)

**END OF SEQUENCE OF OPERATIONS**