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British Columbia
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Bid Fax: (604) 775-9381

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

Vendor/Firm Name and Address
Raison sociale et adresse du
fournisseur/de l'entrepreneur

Issuing Office - Bureau de distribution
Public Works and Government Services Canada -
Pacific Region
800 Burrard Street, Room 219
800, rue Burrard, pièce 219
Vancouver
British C
V6Z 0B9

Title - Sujet Office Relocation Osoyoos POE	
Solicitation No. - N° de l'invitation EZ899-180220/A	Amendment No. - N° modif. 002
Client Reference No. - N° de référence du client	Date 2017-06-21
GETS Reference No. - N° de référence de SEAG PW-\$PWY-028-8063	
File No. - N° de dossier PWY-7-40029 (028)	CCC No./N° CCC - FMS No./N° VME
Solicitation Closes - L'invitation prend fin at - à 02:00 PM on - le 2017-07-06	Time Zone Fuseau horaire Pacific Daylight Saving Time PDT
F.O.B. - F.A.B. Plant-Usine: <input type="checkbox"/> Destination: <input checked="" type="checkbox"/> Other-Autre: <input type="checkbox"/>	
Address Enquiries to: - Adresser toutes questions à: Lam (PWY), Tian	Buyer Id - Id de l'acheteur pwy028
Telephone No. - N° de téléphone (604) 363-7968 ()	FAX No. - N° de FAX (604) 775-6633
Destination - of Goods, Services, and Construction: Destination - des biens, services et construction: PWGSC - Okanagan and Kootenay District Office Relocation (Osoyoos POE)	

Instructions: See Herein

Instructions: Voir aux présentes

Delivery Required - Livraison exigée	Delivery Offered - Livraison proposée
Vendor/Firm Name and Address Raison sociale et adresse du fournisseur/de l'entrepreneur	
Telephone No. - N° de téléphone Facsimile No. - N° de télécopieur	
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

Les documents français seront disponibles sur demande.

The Solicitation Amendment 002 is raised to issue Addendum #1, publish amended specification sections, publish the site visit attendees and extend the bid closing date and time.

- 1) Please find Addendum #1 herein.
- 2) The amended specification sections can be found within Addendum #1.
- 3) A site visit was held on June 19, 2017.
The companies that attended the site visit are as follows:

Wildstone
BritechHVAC
Phil's Floors (2015) Ltd.
Combined Mechanical Contractors
- 4) The Solicitation Amendment 002 is issued extend the bid closing date of this solicitation.

Extension of Time for Tenderers

Office Relocation Osoyoos POE
Okanagan and Kootenay District Office, Osoyoos, B.C
Solicitation No: EZ899-180220/A

Notice is hereby given that the time for reception of tenders previously due at 2:00 p.m. P.D.T. on June 27, 2017 is hereby extended to **2:00 p.m. P.D.T. on July 6, 2017.**

All other terms and conditions remain unchanged.

ADDENDUM #1

Date: June 20, 2017

Okanagan and Kootenay District Office Relocation
OSOYOOS, B.C.
Project No: R.082890.001

The following revisions supersede the information contained in the original drawings and specification issued for the above named project, and shall become part thereof. No consideration will be allowed for extras due to the contractor or any subcontractor not being familiar with this Addendum.

1.0 CLARIFICATION

- 1.1 Question: Mechanical Drawing M0.1 refers to a Break Out Price 1. Such a Price does not appear on the GC's Bid Form. Can you please clarify?

Response: Only the successful bidder will need to provide a break out price after award of contract. Bidder does not need to provide when submitting their tender.

2.0 SPECIFICATIONS

- 2.1 Refer to PDF document of Specifications:
Replace Divisions 21,22,23,25 with the attached Divisions 21,22,23,25

END OF ADDENDUM #1

1. GENERAL

1.1 Work Included

- .1 Refer to Division 23 05 00 Common Works Results for HVAC

1. GENERAL

1.1 Work Included

- .1 Fire protection system piping and accessories.
- .2 Sprinkler heads.
- .3 Valves.
- .4 Hydraulic calculations and shop drawings.
- .5 Fire extinguishers and cabinets.

1.2 Quality Assurance

- .1 All work shall be installed in accordance with the current edition of NFPA No. 13, Standard for Installation of Sprinkler Systems.
- .2 All workers engaged in the construction or modification of the fire protection system shall be journeymen who have Trades Qualifications as Sprinkler Fitters under Province of British Columbia legislation, or are indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.
- .3 All material, equipment, valves and devices installed and/or furnished under this section shall be listed and/or approved for use in fire protection installation by the following agencies or codes.
 - .1 Factory Mutual Engineering Association.
 - .2 Underwriters' Laboratories of Canada.
 - .3 Underwriters' Laboratories Incorporated.
 - .4 National Fire Protection Association.
 - .5 Local Fire Department.
- .4 Fire extinguishers must conform to any one of the following National Standards: ULC-S504, CAN4-503, ULC-S512, CAN4-S507.
- .5 External fire pumper connections shall comply with the sizing standards of the local fire department.

1.3 Design Criteria

- .1 Design density requirements are as prescribed in the current edition of NFPA Standard 13.
- .2 Light hazard occupancies include the following: classrooms, administration offices, staff lounge, gymnasiums, lobbies, corridors, lunchrooms, washrooms, libraries (with low book stacks), music and drama, rooms, gymnasia.
- .3 Ordinary Hazard Group 1 occupancies include the following: mechanical rooms, janitor rooms, storage rooms, equipment rooms, business classrooms, computer classrooms, home economics classrooms, stage, stage wings, elevator shaft, crawl spaces.
- .4 Ordinary Hazard Group 2 occupancies include the following: science laboratories, metal workshops, auto shops, woodworking shops.

1.4 Submittals - Prior to Construction

- .1 Submission details and requirements shall be as prescribed in the current edition of NFPA Standard 13.

- .2 Equipment Shop Drawings: Submit technical and maintenance detail for the following equipment:
 - .1 Each type of sprinkler head
 - .2 Sprinkler head guards
 - .3 Accessory valves
 - .4 Extinguishers, including rating and capacity
 - .5 Extinguisher cabinets
 - .6 Pressure gauges
- .3 System Shop Drawings and Hydraulic Calculations
 - .1 Hydraulic calculations and shop drawings must be sealed by a qualified Professional Specialty Engineer.
 - .2 Shop drawings must be submitted in Computer Aided Drafting (CAD) format. The sheet size of the shop drawings must match the tender drawing size.
 - .3 Before commencing the fabrication of installation of the fire protection system, the contractor shall submit one reproducible copy of shop drawings and hydraulic calculations to the Specialty Engineer for review.
- .4 Submit final Specialty Engineer approved shop drawings and hydraulic calculations to:
 - .1 Local authority having jurisdiction.
 - .2 Local Fire Department.
- .5 Submit Schedule SB letter of assurance sealed by a fire protection Specialty Engineer licenced to practice in the province where the work is taking place.

1.5 Submittals – Prior to Substantial Performance

- .1 Include final Specialty Engineer approved working plans and hydraulic calculations as well as approval letter from Insurance Company in each of the Maintenance Manuals.
- .2 Submit completed above ground and below ground Materials and Testing Certificate at completion.
- .3 Signed statement from the local fire department that the thread size on the fire department pumper connection is correct.
- .4 Signed statement from the local fire department that the thread size on the hydrant is correct.
- .5 Submit Schedule SC letter of assurance sealed by a fire protection Specialty Engineer licenced to practice in the province where the work is taking place.

1.6 Hydraulic Calculations

- .1 Hydraulic calculations for the systems shall be performed by the fire protection contractor. Drawings indicate the general layout, configuration and pipe routing required, based on wet grid and loop systems, or dry feeders and branch systems, and shall be followed unless the contractors disclose conflicts which may make any of the installation impractical.
- .2 After tendering, the successful contractor will be responsible to submit hydraulic calculations and shop drawings with the necessary related test data to the Specialty Engineer for review prior to commencing work.
- .3 The contract drawings for this project have been prepared using an AutoCAD computerized drafting system. Include for the cost of updating the original computer software to include all changes recorded on the record white prints.
- .4 If requested, copies of the software drawing file will be made available by the Department Representative on floppy discs prepared with AutoCAD 2002. The drafting system used to produce the shop drawings and final record drawings must be compatible with this system.

- .5 Perform or obtain certified correct tests from the Fire Department or Water Utility for water supply characteristics.
- .6 To expedite the examination of hydraulically calculated sprinkler systems, the following information is to be submitted with the drawings and calculations for acceptance:
 - .1 The direction of flow and the quantity flowing in each pipe leading to or in the design area chosen.
 - .2 The type of pipe and the C factor used for piping in the system and in the underground supply to the system in addition a "K" factor is required.
 - .3 A node diagram with indication of the discharge quantities from each sprinkler and the pressures applying at each node point.
 - .4 A supply and a demand curve at a common reference point (to be stated) on semi-log graph paper to show the relationship between the sprinkler and hose demand against the actual supply. Design for the water supply to be capable of supplying 20% more in volume than the total sprinkler demand and 10% more pressure at the base of the riser. When water supply information is obtained from a third party, a copy of the written confirmation indicating the amount available, the pressure available, the reference point, the time and date of test and the person or persons who made the test.
 - .5 Show dimensions between sprinkler heads and branch lines.
 - .6 Indicate capacity of sprinkler system when flooded in U.S. gallons.

1.7 Record Drawings

- .1 Refer to Section 23 01 00, Documentation, Manuals and Record Drawings.

1.8 Acceptable Contractors

- .1 Construction companies, whether tendering as sub-contractors or prime contractors, that are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Integrated Fire Protection Ltd., Kelowna, BC
 - .2 Total Mechanical Systems Inc., Kelowna, BC
 - .3 Okanagan Fire Protection Services Ltd, Kelowna, BC
 - .4 Chapman Fire Protection, Vernon, BC
 - .5 Troy Sprinkler Limited, Chilliwack, BC
 - .6 BTR Fire Protection Ltd, Kelowna, BC

1.9 Acceptable Manufacturers

- .1 Manufacturers of fire extinguishers and cabinets whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 CEB, National Fire Equipment, Flag, Wilson and Cousins, Silverline, Chubb.
- .2 Manufacturers of automatic sprinkler valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Globe, Grinnell, Vipond, Astra, Viking, Central, Gem, Star.
- .3 Manufacturers of sprinkler heads and equipment whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Automatic, Grinnell, Vipond, Viking, Astra, Globe, Central, Gem, Star, Reliable, Victaulic.
- .4 Manufacturers of sprinkler pipe fittings identified in Section 23 05 05.

1.10 Special Conditions

- .1 Provide 48 hours' notice to the Departmental Representative prior to disruption of systems. Obtain approval prior to proceeding with systems shutdown or disruption.

- .2 Systems are to be provided with temporary work as required to maintain systems in operation at all times. Short periods of discontinuous service may be approved for reconnection, modification or renovation of services or systems.
- .3 Systems outside the work area are not to be left in inoperable conditions overnight.
- .4 The Departmental Representative may instruct the Contractor to activate systems in the area of work even if the remainder of the construction and installation of building components is not complete. The Contractor must schedule his work to allow minimal periods of inoperable system operation in the area of work.

2. PRODUCTS

2.1 Sprinkler Heads and Escutcheon Plates

- .1 Sprinkler heads installed shall be upright sidewall or pendant, as conditions and density require, and shall be of the proper type and finish for the building and/or areas designated.
- .2 Sprinkler heads in attic or ceiling spaces, crawl spaces and on unfinished exposed piping, except where noted, shall be brass finish upright type.
- .3 Heads for finished ceilings shall be recessed pendent type, with chrome plated finish and escutcheon plates. The escutcheon plates shall cover all of the pendent piping, up to the sprinkler head.
- .4 Heads in light hazard occupancies shall be quick response type, if required.

2.2 Sprinkler Head Guards

- .1 Head guards shall be approved by the sprinkler head manufacturer for use on the sprinkler head approved.

2.3 Nameplates - Hydraulic Data Plates

- .1 Comply with current edition of NFPA Standard No. 13, Mounted on riser above each sprinkler alarm valve.

2.4 Test Pipes and Test Modules

- .1 Flow Test Modules: ULC, FM approved ductile iron body, separate bronze fitted valves for drain and test operation, acrylic sight glass, internal replaceable orifice with four sized, EPDM gaskets, threaded connection. Equal to Viking Testmaster Style 718.
- .2 Test Valve: Single ball valve, threaded test pipe and cap, 25 mm diameter.
- .3 Provide engraved plastic label on each unit, identifying zone of service.

2.5 Sprinkler Isolation Valves

- .1 All valves for the sprinkler systems shall be designated to withstand a working pressure of 1,200 kPa (175 psig). Valves 50 mm or smaller to be bronze construction with screwed connections.
- .2 Valves isolating automatic valves shall be gear operated butterfly valves complete with integral tamper switches.
- .3 Refer to Section 23 05 23.

2.6 Piping

- .1 Refer to Division 23 05 05

2.7 Fittings

- .1 Sprinkler System Less than 64 mm diameter: Threaded, Malleable Steel. Welded, same thickness as pipe.
- .2 Branch Mains and Tees 64 mm and up: Welded, Flanged, Victaulic. Threaded, Malleable Steel. Welded, same thickness as pipe. Weld-o-lets, full depth. Victaulic, approved clamp, Malleable steel.
- .3 Pressure Ratings: Not less than 1,200 kPa (175 psig) or 350 kPa (50 psig) above maximum static pressure.

2.8 Hangers

- .1 Conform to current NFPA requirements.
- .2 All hangers and components of hangers are to be UL listed for use in sprinkler systems.
- .3 Adjustable, cast or forged ring, or strap type clevis hanger.

2.9 Fire Extinguisher - Type FA

- .1 UL listed for class A, B and C fires, dry chemical ammonium phosphate powder, red finish, complete with semi recessed cabinet (Type 1).
- .2 Strike First (Diamond) 4.5 kg (10 lb), Model ABC-100WWD, ULC Fire rating 6-A/80-BC 135 mm diameter, 520 mm high.

2.10 Fire Extinguisher Cabinets

- .1 Type 1: National Fire Equipment Ltd Fire Extinguisher Cabinet CE-950-3-2-FR to accommodate 10 lb Dry Chemical Extinguisher, full glass door, 2 hour fire rated assembly, grey baked enamel finish to be painted to match existing Cabinets on main floor.

2.11 Pressure Gauges

- .1 Steel case, 90 mm diameter minimum, phosphor bronze bourdon tube brass movement, extruded brass socket.
- .2 Provide brass needle shutoff valve.
- .3 All gauges shall be calibrated in S.I. (Metric) Units and Imperial Units.

3. EXECUTION

3.1 General

- .1 Sprinkler piping will be concealed throughout the project, except where specifically noted.
- .2 Sufficient heat will be maintained by the building operator, in areas which are theoretically warm spaces, to prevent piping freezing.
- .3 Wall, ceiling and floor penetration – distribution piping greater 65 mm and over: Cast metal floor and ceiling plates with set screws.
- .4 Wall, ceiling and floor penetration – sprinkler head piping less than 65 mm: Chrome finished split rings, complete with fastening screws.
- .5 Provide sleeves whenever pipes pass through concrete or concrete block walls. Maintain a 12 mm annular clearance between sleeves and pipe. Pack sleeves with flexible material equal to and to maintain fire rating of wall.

3.2 Identification and Labelling

- .1 Provide identification schedule for Maintenance Manuals.
- .2 Isolation Valves: Stamped or engraved metal or engraved plastic tags identifying valves.
- .3 Flow Test Modules or Flow Test Valve: Stamped or engraved metal or engraved plastic tags identifying zone of service.

3.3 Sprinkler Heads

- .1 Head type, configuration and placement shall comply with the specification requirements as well as notation requirements on plans.
- .2 Provide extended escutcheons if necessary to clear obstructions.
- .3 Align heads in common locations.
- .4 Heads in T-bar ceilings shall be positioned on both centrelines of standard lay-in panels. If it is not possible to install heads on both centrelines, heads are to be installed on one centreline which is common with adjacent panels. All heads in T-bar ceilings are to be aligned in both directions. Heads are not to be re-positioned from the locations shown on drawings in order to reduce the number of heads.
- .5 Provide approved sidewall heads where required, or shown. Ensure heads are approved for range required to provide coverage.
- .6 Temperature rating shall suit the specific area with a minimum margin of safety of 10 degrees C.
- .7 The proximity of head to heat generating equipment shall be taken into consideration in determining the temperature ratings.
- .8 All sprinklers in concealed spaces subject to excessive temperature such as roof spaces, to be the 100 degree C rating.
- .9 Where piping is being used to feed upright sprinklers from below the ceiling, the hole is to be cut to allow the passage of pipe and head, and an escutcheon plate shall be used to finish the opening. Provide insulation if piping passes from heated to unheated space.
- .10 The support stems on upright heads shall be aligned with the centre line of the pipe on which they are mounted.
- .11 Make minor sprinkler head placement changes on site due to site conditions at no extra cost.
- .12 **Provide preliminary head layout to the Departmental Representative for review and coordination. Allow for one meeting in Vancouver with the Coordinating Professional to make adjustments as required to suit architectural requirements. Re-submit the final drawing for review and approval electronically.**

3.4 Sprinkler Head Guards

- .1 Any sprinkler head that is subject to mechanical injury shall be protected with a listed head guard.
- .2 Be prepared to demonstrate acceptability of selected guard by activation of an installed head, by melting the link.
- .3 Areas in which sprinklers are considered to be at risk from mechanical damage and require guards are as follows:
 - .1 All areas throughout where sprinkler heads are less than 2,900 mm above floor.
 - .2 Mechanical Rooms
 - .3 Electrical Rooms
 - .4 All exterior sprinkler heads.

3.5 Test Modules and Test Pipes

- .1 Wet Pipe System: A test module controlling a 25 mm inspector's test with a smooth bore corrosion resistant orifice to provide a flow equivalent to one sprinkler of a type installed on the particular system shall be installed on the end of the most distant sprinkler line in the upper story and shall be equipped with a cast iron or brass plug.

3.6 Piping

- .1 Route piping in orderly manner and maintain proper grades.
- .2 Install to conserve head room and interfere as little as possible with use of space.
- .3 Run exposed piping parallel to walls.
- .4 Group piping wherever practical at common elevations.
- .5 Slope piping as required and arrange to drain at low points.
- .6 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .7 Provide clearance for proper installation of fittings, and for access to valves, drains and unions.
- .8 Wet system piping is not to be run in areas which are unheated and considered theoretically cold.
- .9 Piping shall be run in such a manner as not to pass under light fixtures. Field measurements, not the drawings, will determine routing. Extra will not be allowed for changes due to this requirement.
- .10 Make minor piping placement changes on site due to site conditions at no extra cost.

3.7 Hangers

- .1 In finished areas, plastic or chrome plated ceiling plates shall be provided for all hanging rods.
- .2 All piping shall be braced and provided with flexible couplings to provide protection against earthquakes as required by the current edition of NFPA Standards 13, 14 and 20.
- .3 The distance between a hanger and the centreline of an upright sprinkler shall be no less than 75 mm.
- .4 The unsupported length between the end sprinkler and the last hanger shall not be more than 450 mm for 25 mm pipe, or 600 mm for 30 mm pipe. When these limits are exceeded, the pipe shall be extended beyond the end sprinklers and supported by an additional hanger.
- .5 Risers shall be supported by attachments directly to the riser or by hangers located on the horizontal connections close to the riser.
- .6 Riser supports shall be provided at ground level and at each third level above. Where risers are supported from the ground, the ground support constitutes the first level of riser support.
- .7 Sprinkler risers in vertical shafts, shall have at least one support for each riser pipe section.

3.8 Drains

- .1 The 50 mm or 30 mm system drains shall be run to outside of the building. Auxiliary drains shall be run to a point where they are accessible and equipped with valve, nipple, and cap or drum drips, as per current NFPA requirements.
- .2 Water alarm drains shall be run to outside of building, to an adequate disposal area or storm sewer.
- .3 Drains shall be positioned so as not to cause undue destruction of landscaping or create water or ice hazards. Discharges shall be located to prevent damage during full flow testing. Selection of locations is the responsibility of this Division.
- .4 Drain outlets are not to be positioned less than 2.0 metres above outside finished grade.

- .5 Drains shall be provided with NPT, male threads at discharge, and threaded cap.
- .6 A copy of location and size of all drains and low points on these systems must be kept at valve station.

3.9 Fire Extinguishers and Cabinets

- .1 Extinguishers greater than 18 kg: Mount cabinets so top of extinguisher is 1,000 mm from floor.
- .2 Extinguishers less than 18 kg: Mount cabinets so top of extinguisher is 1,500 mm from floor.
- .3 Turn over extinguisher cabinets to Prime Contractor for installation.

3.10 Flushing of Piping

- .1 Connection for flushing shall be made to the building services shutoff valve through properly secured pipe work to the outside of the building.
- .2 Flushing water must not be passed through the double check valve assembly.
- .3 The Fire Department sprinkler inlet pipe may be used for discharge service if the check valve clapper is removed.
- .4 Discharge of the large amounts of water required must not lead to any damage at either discharge point or surrounding area.
- .5 The Department Representative must be given 48 hours' notice of the fire main flush after permission has been received from the water utility.
- .6 The flushing test must be properly recorded on the Contractor's Material and Test Certificate for Underground piping.

3.11 Inspections and Tests

- .1 Provide all labour and equipment for all phases of final inspections, examinations, and tests required to obtain complete and final acceptance of the fire protection system.
- .2 Notify the Department Representative in writing when final inspection of the installation may be performed. The Department Representative shall be reimbursed by the Contractor for time and expenses involved in subsequent inspections resulting from deficiencies noted during final inspection.
- .3 Flow and pressure tests shall be conducted only when weather permits. Contracts will not be considered totally performed until satisfactory tests are conducted and reported.
- .4 Bleed all air from system so that alarm devices shall activate no less than 60 seconds after test valves are opened.
- .5 Sprinkler system discharge tests shall be conducted using system test pipes described. Pressure gauges shall be installed at critical points and readings taken under various modes of auxiliary equipment operation. Water flow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.
- .6 Tests shall be executed with all trim and accessories in normal operating condition, air compressors and excess pressure pumps in auto mode, accelerators and retarders enabled, etc.

3.12 Wet System Test and System Pressure Integrity:

- .1 Comply with all requirements of NFPA and this specification with respect to testing, reports and certifications.
- .2 Substantial Performance Inspection: Demonstrate that the fully charged system does not lose water pressure greater than 10 kPa (1.5 psig) over a 72 hour period. Submit reports.

- .3 Warranty Inspection: Demonstrate that the fully charged system does not loose pressure greater than 10 kPa (1.5 psig) over a 72 hour period. Note that this requirement for integrity of the piping system and accessories will be applied to the performance of the system during and after the warranty period. Failure of the system to maintain this standard, due to deterioration or failure of piping, couplings or accessories, will be viewed as a latent construction defect. Correction of such a defect will be considered as the responsibility of the Contractor. Since failures of this type are usually a fault of the couplings and seals, the Contractor is admonished to carefully select, install and test the couplings as well as all other accessories.

3.13 Placing in Service

- .1 When the entire fire protection system has been completed to the satisfaction of the Departmental Representative, including deficiencies, this Contractor shall demonstrate the complete operation and maintenance required to the Departmental Representative, and the local fire department.

3.14 Existing Systems

- .1 Install isolation valves on existing fire protection systems to isolate only piping feeding the area of work. Piping systems outside the area of work may be left in inoperable condition only for the period of time necessary to complete direct renovation of the piping systems. Activate the systems as soon as the piping systems are complete.
- .2 Isolation valves must be removed from the fire protection system when all work is complete.
- .3 Fire protection systems outside the work are not to be left in inoperable conditions overnight.

1. GENERAL

1.1 Work Included

- .1 Fire protection system, accessories testing and inspection and reports including but not limited to:
 - .1 Fire sprinkler systems and accessories.
 - .2 Alarm initiating devices and annunciation.

1.2 Quality Assurance

- .1 All tests, certifications and work shall be executed in accordance with the following standards:
 - .1 NFPA No. 13, Standard for Installation of Sprinkler Systems.
 - .2 NFPA No. 14, Standard for Installation of Standpipe and Hose Systems.
 - .3 NFPA No. 25, Standard for Water-Based Fire Protection Systems, 1992 Edition.
- .2 Testing technicians shall be certified by the Association of Applied Science Technologists and Technicians of British Columbia as Registered Fire Protection Technicians.
- .3 All workers engaged in the testing and certification of the fire protection systems shall be journeymen who have Trades Qualifications as Sprinkler Fitters under Province of British Columbia legislation. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.

1.3 Design Criteria

- .1 Prior to commencing tests and certifications, review record drawings and calculations with respect to systems operation requirements, design density requirements, history, etc.

1.4 Submittals - Prior to Construction

- .1 Submission details and requirements shall be on forms and as prescribed in:
 - .1 The current edition of applicable NFPA Standards, or
 - .2 The BC Association of Applied Science Technologists and Technicians Fire Protection Testing curriculum, or
 - .3 Other forms approved by the Department Representative,

1.5 Submittals - Prior to Substantial Performance

- .1 Copy and complete report forms included at the end of this section.
- .2 Submit final test results and certifications to:
 - .1 Departmental Representative.

1.6 Record Documents

- .1 Will be provided by the Departmental Representative.

1.7 Special Conditions

- .1 Provide 48 hours' notice to the Departmental Representative prior to disruption of systems. Obtain approval prior to proceeding with systems shutdown or disruption.
- .2 Inform Departmental Representative's Maintenance Department and Emergency Reception Centre of intention to carry out sprinkler testing.
- .3 Systems are to be provided with temporary work as required to maintain systems in operation at all times.

- .4 During periods of normal school operating, work must be done without disruption of normal school activities. As an alternative, work could be executed either before or after normal school operating hours.

2. PRODUCTS

2.1 General

- .1 The sprinkler system forms part of a fire alarm detection system. Tests must consider the impact on all components of the system including but not limited to flow switches, low water and air pressure trouble monitoring devices and supervisory tamper switches on all gate valves.

2.2 System Test Pipes – Existing

- .1 Wet Systems: A test pipe is installed for each system, of not less than 25 mm diameter. For test purposes, provide a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler. Remove after test.
- .2 Where water flow alarm devices are provided at each riser on each floor or where more than one alarm device is provided in one sprinkler system, a test pipe is provided for testing each alarm device.

3. EXECUTION

3.1 Sprinkler Heads

- .1 Check general configuration and placement of all heads in system. Confirm that heads are positioned in a manner that does not impair performance, activation, spray pattern, etc.
- .2 Check several, but not all heads on each system to confirm that temperature rating, K factor, flow characteristics match design record drawings and calculations.
- .3 Inspect heads in cupboards and storage areas to check that they are not obstructed by storage materials.

3.2 Sprinkler Head Guards

- .1 Confirm that guards on dry sidewall or dry pendant heads are a type that has a large hole in the centre to allow the plunger rod to be thrown clear of the head during activation.
- .2 Confirm that guards are installed in all heads in areas as follows:
 - .1 All areas throughout where ceiling height is less than 2,900 mm.
 - .2 Mechanical Rooms
 - .3 Electrical Rooms

3.3 Sprinkler Station - Wet Systems

- .1 Remove inspection cover on each valve and confirm all fittings and components in good working order and condition. Change valve washer and consumable components as required.
- .2 Submit the following data on test reports:
 - .1 Location, including street address.
 - .2 System or device identification and schematic diagram.
 - .3 Date of original installation.
 - .4 Design water pressure and flow requirements for each system.
 - .5 Copy of original Materials and Testing Certificate.
 - .6 Sprinkler valve(s): manufacturer, model identification, ratings, approvals and listings.
 - .7 Water service: street pressure.

- .8 Static test reports: systems identifications, water utility side pressure, intermediate chamber pressure, systems side pressure, excess pressure pump start and stop settings.
- .9 Flow test reports: systems identifications, test pipe or module locations, pressure before, during and after tests, test duration, water motor gong confirmation, etc.
- .10 Trouble monitoring test reports: systems identifications, confirm all tamper switch operations, test and record pressure monitoring device activations.
- .11 Annunciation reports: Individually confirm and report that the proper indication of each trouble and alarm device is correctly annunciated on the fire alarm panel and the graphic annunciator.
- .12 Example of form to be used is attached.

3.4 Main Drain Floor Test

- .1 The main drain valve shall be opened and remain open until the system pressure stabilizes. The static and residual pressures shall be recorded on the contractor's test certificate.
- .2 The reading must be compared to the original test certificate pressure to ascertain if there has been any degradation in water flow and pressure available.

3.5 Piping

- .1 Generally check and comment on condition, support, and configuration of piping, drain ability and grades.
- .2 If necessary, provide temporary discharge piping from each test point or module to the exterior or to the nearest storm drain.

3.6 Hangers

- .1 Generally check and comment on condition, support, and configuration of hangers.

3.7 Inspections and Tests

- .1 Provide labour and equipment for all inspections, examinations, and tests required.
- .2 Notify the Departmental Representative when inspections and tests are to be performed.
- .3 At the discretion of the Departmental Representative, the Departmental Representative may attend or request a repeat demonstration of any tests.
- .4 Flow and pressure tests shall be conducted only when weather permits.
- .5 Sprinkler system discharge tests shall be conducted using system test pipes described. Pressure gauges shall be installed at critical points and readings taken under various modes of auxiliary equipment operation. Water flow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.
- .6 Tests shall be executed with all trim and accessories in normal operating condition, air compressors and excess pressure pumps in auto mode, accelerators and retarders enabled, etc.

3.8 Placing in Service

- .1 When the entire fire protection system has been tested, activate the system for automatic operation.
- .2 Confirm in writing to the Departmental Representative that tests are complete and reports are being prepared.
- .3 Submit reports as specified, as soon as possible.

1. GENERAL

1.1 Work Included

- .1 Cleanouts.
- .2 Floor drains.
- .3 Plumbing vents.
- .4 Trap primers
- .5 Sanitary sewer disposal systems and connections.

1.2 General Requirements

- .1 Provide materials, equipment and labour to install plumbing as required by Provincial and local codes as specified herein.
- .2 Provide water and drainage connections to equipment specified in other sections of this specification.

1.3 Quality Assurance

- .1 Provide new equipment, CSA approved.

1.4 Submittals - Prior to Construction

- .1 Floor drains: Accessories, dimensions and installation details.

1.5 Acceptable Manufacturers

- .1 Manufacturers of floor drains whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Zurn, Ancon, Mifab, Smith, Watts, Wade.

2. PRODUCTS

2.1 Cleanouts and Cleanout Accessories

- .1 Sanitary: Provide caulked or threaded type cleanouts extended to unfinished floor or wall surface.
- .2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Wall cleanouts shall be located behind approved access panels.

2.2 Floor Drains

- .1 Floor drains in equipment rooms for picking up indirect waste, shall have integral cast funnel type strainer.
- .2 Floor drain, concrete floor, above grade: Floor drain shall have lacquered cast iron body with double drainage flange, primer connection, combined two piece body, reversible clamping device and adjustable nickel bronze strainer. Equal to Ancon FD-100-C-A-1-7.

2.3 Trap Primers

- .1 Electronic timed trap primers shall be complete with internal air gap, manifold, 120V controller, solenoid valve and enclosure. Equal to Precision Plumbing Products Mini-Prime or Precision Plumbing Products Prime-Time.

3. EXECUTION

3.1 Installation

- .1 Install gas piping in open or ventilated spaces. Pitch lines and provide drip legs for condensation collection points. Where gas piping is run in a concealed space, provide ventilation grilles as required.
- .2 Each trap primer should serve only one piece of equipment. Install trap primers:
 - .1 Where required by Codes
 - .2 Funnel floor drain
- .3 Drainage lines shall grade 2% grade unless otherwise shown on drawings.
- .4 Underground drainage lines shall be sized at 75 mm minimum unless otherwise noted.
- .5 Install sanitary wye or double wye fittings on all drainage systems. Tee or double tee fittings are not permitted.
- .6 Provide individual domestic water isolation valves for all plumbing fixtures, including water closets, lavatories, trap seal primer and sink.

3.2 Cleanouts and Access Covers

- .1 Unless otherwise noted, floor cleanouts in finished areas are not approved.
- .2 Ensure ample clearance at cleanout for rodding of drainage systems.

3.3 Vents and Pipe Penetrating Roof/Walls

- .1 Vent, gas and refrigerant pipes shall project through the roof (or walls) shall be provided with specified roof jack and flashing flange. Flashing shall be extended 300 mm clear on all sides of projecting pipe.
- .2 Provide standard flashing caps as specified.
- .3 Vents specified or provided with vandal resistant, close slotted vent caps shall not be sized less than 50 mm.
- .4 Refer to Section 23 05 23 Hangers and Supports for HVAC Piping and Equipment.
- .5 Cap and seal existing unused vents. Seal vents by removing the vent pipe, caulking and crimping the lead jack, secure with clamp or other approved means.

3.4 Floor Drains

- .1 Connect to trap primer.
- .2 Set drain at elevation to allow finished floor to slope to mouth. Coordinate setting elevation with floor finish thickness.
- .3 Provide flashing of sheet lead or approved non-metallic membrane where floor drains are located over occupied spaces.

3.5 Trap Primers

- .1 Each manifold connection shall serve no more than one trap.

3.6 Service Connections

- .1 Before commencing work, check invert elevations required for sewer connections. Confirm inverts and ensure that these can be properly connected with sufficient slope for drainage.
- .2 Connect to existing sanitary sewer services as shown on drawings.
- .3 Connect to existing domestic water services as shown on drawings.

- .4 Connect to existing natural gas services as shown on the drawings. Gas service distribution piping shall have initial minimum pressure as shown on drawings. Provide regulators on each line servicing appliances, sized in accordance with equipment

3.7 Condensate Drains

- .1 Extend drains from heat pump drain pans to nearby sink, connect above trap, or to indirect drain as shown on drawings.
- .2 Provide backwater valve on drain line to prevent storm water back up through the condensate pan. Back water valve to be installed with unions to allow removal and service. Refer to detail.

Refer to Division 23.

Refer to Division 23.

Project No: R.082890.001
Okanagan & Kootenay District
Office Relocation
Osoyoos, BC

22 13 17
DRAINAGE WASTE AND VENT PIPING
April 2017

Refer to Division 23

1. GENERAL

1.1 Work Included

- .1 Plumbing fixtures and trim.
- .2 Thermostatic mixing valves.

1.2 General Requirements

- .1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.
- .2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.
- .3 Provide fixtures in compliance with local municipality limitations on water consumption.
- .4 Fixtures of any one type shall be by the same manufacturer. Fittings of any one type shall all be by the same manufacturer.

1.3 Job Conditions

- .1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.4 Submittals - Prior to Construction

- .1 Each fixture including related trim and accessories.

1.5 Acceptable Manufacturers

- .1 Manufacturers of plumbing fixtures and accessories whose products are approved in principle, but subject to requirements of drawings and specifications are as follows:
 - .1 Water closets - standard: Mansfield, American Standard, Kohler, Western Pottery, Toto.
 - .2 Water closets - handicapped: Mansfield, American Standard, Kohler, Western Pottery, Toto.
 - .3 Lavatories - vitreous china: American Standard, Crane, Kohler.
 - .4 Kitchen sinks - steel: American Standard, Crane, KIL, Elkay, Kindred, Steel Queen, Novanni, Kohler.
 - .5 Handicapped wash basins - china: American Standard, Crane, Kohler.
- .2 Manufacturers of plumbing fixture trim or accessories whose products are approved in principle, but subject to requirements of drawings and specifications are as follows:
 - .1 Lavatory trim: American Standard, Crane, Delta, Emco, Moen Commercial, Sterling, Waltec, Cambridge, Chicago, Kohler.
 - .2 Mixing valves - Domestic Water Supply: Lawler, Leonard, Powers, Symmons, Watts, Danfoss, Acorn
 - .3 Toilet seats: Olsen, Centeco, Moldex, Bemis.

2. PRODUCTS

2.1 Water Closets

- .1 Type WC-1 equal to American Standard Cadet Pro Right Height Elongated ADA Compliant white toilet model 215AA.165.020. Floor mounted vitreous china with EverClean antimicrobial surface, Powerwash rim siphon, raised sanitary bar and 4 points tank stabilization, 2-piece tank assembly, unlined right hand trip lever, oversized flush valve, metal fill valve and elongated bowl. Consisting of 3517A.101 bowl and 4188A.165 tank, dimensions 438mm wide X 768mm front to back X 768mm high. Water consumption = 4.8L per flush. Centoco 820STSS.001 extra heavy duty elongated Toilet Seat, McGuire LFH172BVRB Toilet Supplies and floor flange.
- .2 Type WC-2 equal to American Standard Cadet Pro Right Height Elongated white toilet model 214AA.174.020 floor mounted vitreous china with EverClean antimicrobial surface, Powerwash rim siphon, raised sanitary bar and 4 points tank stabilization , 2 piece tank assembly, unlined right hand trip lever, oversized flush valve, metal fill valve and elongated bowl. Consisting of 3517A.101 bowl and 4188A.174 tank, dimensions 438mm wide X 768mm front to back X 768mm high. Water consumption = 4.8L per flush. 500STSCCSS.001 Centoco Toilet Seat, Mcquire LFH172BVRB Toilet supplies and floor flange.

2.2 Lavatories

- .1 Type LV-1 equal to American Standard Cadet Universal Access ADA compliant model 9494.001 Self rimming drop in basin, vitreous china and c/w overflow. Bowl dimensions: 441mmX279mmX133mm. Sloan electronic faucet model SF-23350/SFP-46 SF-2000 Series, chrome plated finish, 4" centerset, 1.9L/M outlet, infrared sensor, solenoid valve, control assembly, battery powered, Lawler TMM0-1070 Below deck mixing valve, McGuire 155WC Offset Grid drain & LFH170BVRB supplies.
- .2 Type L-2 equal to wall hung American Standard Murro 0954/0955/0958 series, vitreous china, 127mm deep 540mm WX520mmX165mm high c/w ledge, overflow, self-draining and semi pedestal P-trap cover 0059.020EC. Sloan SF-2350 Electronic Faucet, chrome plated, 4", 1.9 LPM infrared sensor solenoid valve splash proof junction box, battery powered. Lawler 1070 series mixing valve, McGuire 155A series open grid drain and LFH170 series faucet supplies and P-trap. Basin Carrier equal to Watts WCA-411-CA-481.

2.3 Sinks

- .1 Type SK-1. Franke LBD6408-1/4, 3 holes, 8" center plus one 4" hole to right, double bowl, type 302 SS., self-rimming, back ledge, dimensions 794mmX521mmX203mm high c/w Chicago faucet 2301-8abcp single handle faucet, chrome plated, 8" centerset, 2.2 gpm, swing spout 250mm projection, lever handle, side spray c/w McGuire LFH170BVRB Faucet Supplies and P-trap.

2.4 Handicapped Lavatory Trim Insulation

- .1 Insulation: Self-extinguishing, cellular foam insulation.
- .2 Covers: Pre moulded to required shape for trap and drain fittings, secured with a nylon lace or other approved removal method.
- .3 Trap: Removable insulation and cover for trap service without the requirement to remove remaining insulation and covers.
- .4 Supply, hot and cold: Fully covered taps or stops with insulation and pre moulded PVC cover. Stop covers to be 'flip top' removable for quick access to stops without removal of other insulation or covers.
- .5 Colour: White.

3. EXECUTION

3.1 Installation

- .1 Protect fixtures against use and damage during construction.
- .2 Provide chrome plated rigid or flexible supplies to fixtures with ¼ turn ball valve type screwdriver stops, reducers and escutcheons.
- .3 Install wall mounted fixtures with approved wall carriers, model to suit installation.
- .4 Caulk around base, rim or mounting face of all fixtures to seal between floor, counter top or wall.
- .5 Unless otherwise noted rough - in dimensions shall be in compliance with fixture manufacturer's recommendations. Refer to shop drawings or rough - in handbook.
- .6 Install hose and faucets and hose connections with vacuum breakers.

3.2 Thermostatic Mixing Valves

- .1 Provide pressure balanced thermostatic mixing valves on all lavatory and sink faucets.

3.3 Traps

- .1 Sink, lavatory and similar fixture traps to be re to be provided with unions or other approved method for easy and complete removal for servicing and cleaning.
- .2 Trap assemblies concealed in millwork under lavatories and sinks can be converted to approved ABS.

3.4 Handicapped Lavatory Trim

- .1 Set screw stop maximum temperature on supplied fitting to 40 degrees Celsius.
- .2 Exposed supply tail pieces, drains and traps on handicapped fixtures are to be insulated with specified insulation system.

3.5 Lavatory Overflow Drain

- .1 Overflow drain fitting shall be located at the front of the lavatory, or in the least visible location. The ferule shall be an integral part of the lavatory and not visible from the front of the lavatory.
- .2 A single pipe or hose without joints or connections and free of any kinks shall connect the overflow drain to the trap.
- .3 Connectors used to connect the pipe or hose to the overflow drain and trap shall be vandal-proof and positioned in such a manner to prevent injury.

3.6 Fixture Mounting

- .1 Mount plumbing fixtures in accordance with standards set out in the British Columbia Plumbing Code, and the standard rough in dimensions or rough-in hand book for the particular fixtures.
- .2 Obtain confirmation of mounting heights from Department Representative prior to rough-in.

Osoyoos POE						
Air Outlet Schedule						
Ident	A	E	G	X	J	K
Description	Plaque	13 x 13 Aluminum Grid Eggcrate	Heavy Duty Gym Grille	Single Deflection EA Grille	Double Deflection SA Grille	Steel Door Grille
Manufacturer	PRICE	PRICE	PRICE	PRICE	PRICE	PRICE
Model	SPD	80	91	530	520	STG1 - 1 BF
Color	White	Prime, White, Metallic	Prime, White, Metallic	Prime, White, Metallic	Prime, White, Metallic	Prime, White
Balancing Damper	NO	No	No	No	No	No
Fire Damper	No	No	No	No	No	No
Backdraft Damper	no	No	No	No	No	No
Accessories And Notes	• 600 x 600 Nominal Module		• Heavy Duty • 10 mm Spacing • 45 Deg Deflection	• 20 mm Spacing • Single Deflection	• 20 mm Spacing • Double Deflection	• Auxiliary Frame For Back Side of Door

Osoyoos POE		
Air Source Heat Pump Schedule		
Ident		CU-1
Status		New
Location		Ground
Service		Fancoil Condensing Unit
Description		Outdoor Air Source VRF, 2 Modules (units) required for this output. Refer to drawings.
Manufacturer		Mitsubishi
Model		PUHY-HP144TSJMU-A
Nominal Size	Ton	12 (Combined Module Output - 6 tons each)
Compressor Cooling Capacity @ 35°C OAT	kW	46.0
Capacity Control		Single stage
Refrigerant		VRF
Compressor Heating Capacity @ -5°C OAT	kW	46.0
Capacity Control		
Width	mm	760 (Each Module - 2 Required)
Length	mm	920 (Each Module - 2 Required)
Height	mm	1650 (Each Module - 2 Required)
Filter	mm	
Weight	kg	450 (Each Module - 2 Required)
Motor	W	See attached.
Voltage/Phase		208V/3ph
MCA	Amps	36.0
Accessories And Notes		<ul style="list-style-type: none"> • c/w snow and rain gaurds • hyper heat low ambient model (-23 degs C) • c/w gas and liquid pipe twinning kit
Controls Coordination		<ul style="list-style-type: none"> • Controlled by DDC System
Electrical Coordination		<ul style="list-style-type: none"> • Div 16 to provide disconnect. Connect power.

Osoyoos POE		
Heat Recovery Ventilator Schedule		
Ident		HRV-1
Status		New
Location		Service Space
Service		O/A Requirements
Description		Indoor Heat Recovery Ventilator
Manufacturer		Renew Air
Model		HE 1X1NH
Outside Air		
Air Flow	l/s	406
External Air Pressure Drop	Pa	125.0
Entering Air Temp	°C	-17
Leaving Air Temp	°C	18
Heat Recovered	kW	
Exhaust Air		
Air Flow	l/s	288
External Air Pressure Drop	Pa	125.0
Entering Air Temp	°C	22
Leaving Air Temp	°C	-17
Core Efficiency		100%
Width	mm	600
Length	mm	1,375
Height	mm	900
Weight	kg	125
Outdoor Air Motor	W	1,270.0
Exhaust Air Motor	W	1,270.0
Voltage/Phase		208/3ph
Accessories And Notes		
Electrical Coordination		<ul style="list-style-type: none"> Div 16 to provide disconnect. Connect power.

Osoyoos POE				
Fan Coil Schedule				
Ident		FC-1	FC-2	FC-3
Status		New	New	New
Location		Gen Office Ceiling	Gen Office Ceiling	Gen Office Ceiling
Service		OFFICE 2,3,North NC215	East NC215	West NC215, OFFICE 1, Quiet
Description		Fan Coil Unit	Fan Coil Unit	Fan Coil Unit
Manufacturer		Mitsubishi	Mitsubishi	Mitsubishi
Model		PEFY-24NMHU-E	PEFY-30NMHU-E	PEFY-27NMHU-E
Nominal Size				
Heating k/w		7.9	10.0	8.8
Cooling k/w		7.0	8.8	7.9
Design Air Flow l/s		317	417	367
Minimum Air Flow l/s				
External Air Pressure Drop Pa		200	200	200
Width mm		750	1,000	1,000
Length mm		900	900	900
Height mm		375	375	375
Motor W		270	360	297
Weight kg		45	50	50
Voltage/Phase		208/1/60	208/1/60	208/1/60
Accessories And Notes		<ul style="list-style-type: none"> ●Provide factory disconnect ●Provide I/O Interface for DDC Connection 	<ul style="list-style-type: none"> ●Provide factory disconnect ●Provide I/O Interface for DDC Connection 	<ul style="list-style-type: none"> ●Provide factory disconnect ●Provide I/O Interface for DDC Connection
Electrical Coordination		●Wire to disconnect	●Wire to disconnect	●Wire to disconnect

Osoyoos POE			
Fan Coil Schedule			
Ident		FC-4	FC-5
Status		New	New
Location		Gen Office Ceiling	Gen Office Ceiling
Service		MEETING ROOM	KITCHENETTE
Description		Fan Coil Unit	Fan Coil Unit
Manufacturer		Mitsubishi	Mitsubishi
Model		PEFY-24NMHU-E	PEFY-15NMHU-E
Nominal Size			
Heating k/w		7.9	5.0
Cooling k/w		7.0	4.4
Design Air Flow l/s		317	233
Minimum Air Flow l/s			
External Air Pressure Drop Pa		200	200
Width mm		750	750
Length mm		900	900
Height mm		375	375
Motor W		270	207
Weight kg		45	45
Voltage/Phase		208/1/60	208/1/60
Accessories And Notes		<ul style="list-style-type: none"> ●Provide factory disconnect ●Provide I/O Interface for DDC Connection 	<ul style="list-style-type: none"> ●Provide factory disconnect ●Provide I/O Interface for DDC Connection
Electrical Coordination		●Wire to disconnect	●Wire to disconnect

Osoyoos POE				
Fan Schedule				
Ident		EXH-F1	EXH-F2	EF-2
Status		new	new	Existing to be relocated to roughly same location
Location		Service Space	Mech	2nd Floor low level
Service		Photocopy Exhaust	Kitchenette Exhaust	Warehouse Exhaust
Description		Cabinet - In Line	Cabinet - In Line	Inline
Manufacturer		Cook	Cook	Cook
Model		70SQN17DEC	90SQN17DEC	
Air Flow l/s		71	36	3,500
External Air Pressure Drop KPa		1.1	1.1	95
Width mm		300	250	
Length mm		375	300	
Height mm		400	350	
Weight kg		41	32	
Motor W		50.0	49.0	3000 Watts
Voltage/Phase		120/1	120/1	208/3
Accessories And Notes		<ul style="list-style-type: none"> • Direct Drive • EC Motor with factory mounted speed control For balancing • Prewired Disconnect • Low Leak Backdraft Damper • Select for Less than 4 Sones • In-Line Fan c/w Suspension kit and 8 ViscoElastic Washers • Fan status to be controlled monitored by local controls system. 	<ul style="list-style-type: none"> • Direct Drive • EC Motor with factory mounted speed control For balancing • Prewired Disconnect • Low Leak Backdraft Damper • Select for Less than 4 Sones • In-Line Fan c/w Suspension kit and 8 ViscoElastic Washers • Fan status to be controlled monitored by local controls system. 	
Electrical Coordination		<ul style="list-style-type: none"> • Hardwire interlock with lights. • Wire to power. 	<ul style="list-style-type: none"> • Provide adjustable timer switch. • Wire to power. 	Reconnect as required

Osoyoos POE			
Unit Heater Schedule			
Ident	UH - 14	UH-15	
Status	Existing - No change	Existing to be relocated	
Location	Devanning Warehouse NC116	Devanning Warehouse NC116	
Service	Heating	Heating	
Description	Hot Water Unit Heater	Hot Water Unit Heater	
Manufacturer	Reznor	Reznor	
Model	WS140/175	WS140/175	
Nominal Size (MBH)	WS140/175	WS140/175	
Heating Capacity kW	41-52	41-52	
Capacity Control	2 stage	2 stage	
Air Flow l/s			
Entering Air Temp °C	4	4	
Leaving Air Temp °C	47	47	
Fluid Type	30% Prop. Glycol	30% Prop. Glycol	
Fluid Flow l/s	0.5	0.5	
Fluid Pressure Drop kPa	8	8	
Entering Fluid Temp °C	82	82	
Leaving Fluid Temp °C	71	71	
Width mm	688	688	
Length mm	488	488	
Height mm	688	688	
Weight kg	45	45	
Motor W	0	0	
Voltage/Phase	120/1	120/1	
Accessories And Notes			
Electrical Coordination	• No Scope	• Disconnect existing electrical service and relocate to new position	

Osoyoos POE			
Unit Heater Schedule			
Ident	UH-16	UH-17	
Status	Existing - No change	Existing to be relocated	
Location	Devanning Warehouse NC116	New location in mechanical room	
Service	Heating	Heating	
Description	Hot Water Unit Heater	Hot Water Unit Heater	
Manufacturer	Reznor	Reznor	
Model	WS140/175	WS140/175	
Nominal Size (MBH)	WS140/175	WS140/175	
Heating Capacity kW	41-52	41-52	
Capacity Control	2 stage	2 stage	
Air Flow l/s			
Entering Air Temp °C	4	4	
Leaving Air Temp °C	47	47	
Fluid Type	30% Prop. Glycol	30% Prop. Glycol	
Fluid Flow l/s	0.5	0.5	
Fluid Pressure Drop kPa	8	8	
Entering Fluid Temp °C	82	82	
Leaving Fluid Temp °C	71	71	
Width mm	688	688	
Length mm	488	488	
Height mm	688	688	
Weight kg	45	45	
Motor W	0	0	
Voltage/Phase	120/1	120/1	
Accessories And Notes			
Electrical Coordination	• No Scope	• Disconnect existing electrical service and relocate to new position	

Osoyoos POE			
Pump Schedule			
Ident	HWCP-2A	HWCP-2B	
Status	Existing to remain / rebalance	Existing to remain / rebalance	
Location	NC205	NC205	
Service	Heating Pumps	Heating Pumps	
Description	Vertical Inline - Centrifugal	Vertical Inline - Centrifugal	
Manufacturer	-	-	
Model	-	-	
Nominal Size	-	-	
Fluid Type	Water	Water	
Fluid Flow l/s	2.5	2.5	
Fluid Pressure Rise kPa	120	120	
Width mm	-	-	
Length mm	-	-	
Height mm	-	-	
Inlet mm	-	-	
Outlet mm	-	-	
Weight kg	-	-	
Motor kW	1.5 kW	1.5 kW	
RPM	1750	1750	
Voltage/Phase	208/3	208/3	
Accessories And Notes	-Lead/Lag	-Lead/Lag	
Electrical Coordination			

Osoyoos POE			
Pump Schedule			
Ident	HWC-1	DHWRP-1	
Status	Existing to be Removed	New	
Location	Water Meter Room	Water Meter Room	
Service	Dom Hot Water Recirc	Dom Hot Water Recirc	
Description	In-Line Circulator	In-Line Circulator	
Manufacturer	-	Grundfos	
Model	-	UP 15-29 SU/LC	
Nominal Size			
Fluid Type	Dom Hot Water Recirc	Dom Hot Water Recirc	
Fluid Flow l/s	1.0	0.07	
Fluid Pressure Rise kPa	60	21	
Width mm	-	150	
Length mm	-	150	
Height mm	-	125	
Inlet mm	-		
Outlet mm	-		
Weight kg	-		
Motor kW	500 Watts	0.75 Amps	
RPM			
Voltage/Phase	120/1	120/1	
Accessories And Notes	-Bronze fitted	<ul style="list-style-type: none"> • 5ft Line Cod with plug • 1/2" Sweat Fitting 	
Electrical Coordination	<ul style="list-style-type: none"> • Disconnect 	<ul style="list-style-type: none"> • Provide Disconnect • Provide electrical receptical . 	

Osoyoos POE		
Tank Schedule		
Ident		NC205-TK1
Status		New
Location		Mech Room NC205
Service		Glycol Fill Tank
Description		Glycol Fill TAnk
Manufacturer		Axiom
Model		SF100
Nominal Size		208 L
System Fill Pressure	kPa	
Capacity	litre	208
Height	mm	1,245
Diameter	mm	610
Inlet	mm	
Outlet	mm	
Full Weight	kg	
Motor	W	0.7A
Voltage/Phase		120/1/60
Accessories And Notes		<ul style="list-style-type: none"> • c/w pump, inlet striner, pressure switch, check valve, cord and plug • CSAapproved • 30% P.G.
Electrical Coordination		<ul style="list-style-type: none"> • Duplex Plug in Near Tank

Osoyoos POE			
Electric Coil Schedule			
Ident		EDH-2	EDH-2
Status		Existing to be Replaced	New
Location		Mech Room NC 205	Mech Room NC 205
Service		HP-2	HP-2
Description		HP-2 Preheat	HP-2 Preheat
Manufacturer			Thermolec
Model			MSC0-10LS-0002-0000
Heating Capacity kW		25.0	25.0
Air Flow l/s		500	500
Air Pressure Drop Pa			
Face Velocity m/s			1.6
Entering Air Temp °C		-20	-20
Leaving Air Temp °C		21	21
Length mm			508
Height mm			305
Diameter mm			-
Weight kg			
Voltage/Phase		208/3 phase	208/3 phase, 70 Amps
Accessories And Notes		5 stage heater	SCR Control c/w Duct Thermostat. Slide in, control on 300 dimension

Osoyoos POE		
Hot Water Coil Schedule		
Ident		HRV1-HC-1
Status		New
Location		HRV-1
Service		Outside Air
Description		Preheat Coil
Manufacturer		Eng Air
Model		3R12
Nominal Size		304x559x3/12
Heating Capacity	kW	25.0
Air Flow	l/s	406
Air Pressure Drop	Pa	78
Face Velocity	m/s	2.5
Entering Air Temp	°C	-17
Leaving Air Temp	°C	30
Fluid Type		30% Prop. Glycol
Fluid Flow	l/s	0.57
Fluid Pressure Drop	kPa	2
Entering Fluid Temp	°C	60
Leaving Fluid Temp	°C	49
Length	mm	559
Height	mm	304
Inlet	mm	0
Outlet	mm	0
Weight	kg	0
Accessories And Notes		<ul style="list-style-type: none"> ● Isolation Valves ● Drain Valves c/w Cap ● Union or Flange Connection ● AAV c/w Ball Valve at High Point ● Three Way Control Valve ● Leaving Water temperature Sensor and Well
Electrical Coordination		<ul style="list-style-type: none"> ● None

Osoyoos POE		
Boiler Schedule		
Ident		B-2
Status		Existing to be Remain
Location		Mechanical NC205
Service		Hydronic Heating
Description		Standard Efficiency Power Vented Boiler
Manufacturer		Lochinvar
Model		CBND495
Nominal Size		495
Heating Input kW		145.0
Heating Output kW		127.0
Efficiency %		81.0%
Capacity Control		2 stage
Fluid Type		Water
Fluid Flow l/s		
Fluid Pressure Drop kPa		
Entering Fluid Temp °C		
Leaving Fluid Temp °C		
Minimum Operating Temperature °C		
Maximum Operating Temperature °C		
Width mm		585
Depth mm		1,168
Height mm		1,100
Inlet mm		50
Outlet mm		50
Vent mm		150
Combustion Air mm		
Weight kg		227
Voltage/Phase		120/1
MCA Amps		
Accessories And Notes		● Natural Gas
Electrical Coordination		● Disconnect Existing Electrical Service

1. GENERAL

1.1 Work Included

- .1 Operating and Maintenance Manuals.
- .2 Assembly of equipment start up and performance tests and reports for new, renovated or necessary existing systems.
- .3 Assembly of equipment details sheets and shop drawings for new, renovated or necessary existing systems.
- .4 Assembly of equipment and systems operating and maintenance instructions for new, renovated or necessary existing systems.
- .5 Assembly of final permits for new, renovated or necessary existing systems.
- .6 Record Drawings.

1.2 Acceptable Agencies

- .1 Agencies who are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 KD Engineering Ltd., Vancouver
 - .2 Vesta Dynamics, Kelowna.
 - .3 Inland Technical Services Ltd., Kelowna.
 - .4 West Rockies Services, Abbotsford

2. PRODUCTS

2.1 Operation and Maintenance Materials

- .1 Provide one hard copy in a 215 mm x 280 mm 3 post type catalogue binder, lettering front and spine, plastic tab dividers. Binder should be identified by both volumes if required.
- .2 Provide one readable/writeable (R/W-CD) compact disk labelled and contains the specified materials in Portable Document Format (PDF).
- .3 Manufacturers' data section is to be indexed and ordered to exactly match the sections of the specifications, including section numbering. Each section of the manufacturers' data section is to include an up to date copy of the equipment schedule for that section, with the same format as the equipment schedules in the tender document. The schedule is to be revised to suit all addenda, change orders and field changes, as well as manufacturers and model numbers matching the equipment supplied. Assemble or develop complete and correct documentation for the operation and preventative maintenance of equipment and systems provided.
- .4 Assemble or develop copies of all certified shop drawings and material required to complete the documentation. This generally includes but is not limited to the following:
 - .1 Comprehensive description of the operation of the systems, including the function of each item of equipment within the system.
 - .2 Permits
 - .1 Plumbing
 - .2 Gas
 - .3 Boiler
 - .4 Refrigeration
 - .3 Detailed instructions for the normal maintenance of all systems and equipment installed including procedures and frequency of operational checks and service, and troubleshooting instructions.

- .4 Operating and maintenance schedule, indicating location, grades (grease or oil) for all lubricated equipment components.
- .5 Local source of supply for each item of equipment.
- .6 Shop drawings, including the Department representative's review stamp and comments.
- .7 Air system balance report.
- .8 Water system balance report.
- .9 Equipment start up reports as per manufacturer requirements.
- .10 Equipment start up reports to detail as left settings
- .11 Material Safety Data Sheets for all chemicals.
- .12 Chemical cleaning and treatment report for piping systems.
- .13 Disposal procedures for all chemicals provided.
- .14 Chemical emergency procedures.
- .15 Cleaning report for air duct systems.
- .16 Chlorination report for water mains.
- .17 Warranties, certificates and miscellaneous reports.
- .18 Manufacturers' operating and maintenance brochures, and shop drawings, including wiring diagrams, fan performance data, pump curves with the operating point indicated, and control maintenance bulletins.
- .19 Plumbing Fixture Brochure.
- .20 Filter type, specification, model number, efficiency rating, and thickness, correlated with air handling equipment identification.
- .21 Completed equipment inventory and submittal sheets.
- .22 Statutory inspection details.
- .23 Control device setting record sheets.
- .24 N.F.P.A. Standard No.25, "Standard for the Inspection, Testing and Maintenance of Water Based Fire Protection Systems".
- .25 Sprinkler system materials and testing certificate.
- .26 Departmental Representative approved working plans and hydraulic calculations for sprinkler system.
- .27 Insurance company approval letter for sprinkler system.
- .28 Letters of assurance from Fire Protection Department representative.
- .29 Letters of assurance from Seismic Specialty Engineer.
- .30 Instructions for emergency operation, maintenance and shutdown of all systems.
- .31 Record Drawings photo reduced to 430 mm x 280 mm.
- .32 Copies of all Receipts for equipment handed over to the Departmental Representative.

2.2 Record Drawings

- .1 Contractors shall certify final reproducible Record Drawings to be correct by notation and signature on the drawings.
- .2 Record drawings shall precisely identify the configuration, size and location of all systems and equipment installed under this Division, including but not limited to:
- .3 Before Substantial Completion submit for approval to the Department representative, completed and detailed marked up white prints to reflect the record drawing status.

- .4 A Cash Allowance has been specified to cover the Departmental Representative's cost of the following:
 - .1 Updating the original computer software to include all changes recorded on the record white prints.
 - .2 Plotting one set of full size reproducible record drawings.
- .5 The Departmental Representative shall distribute the following record materials provided under the Cash Allowance.
 - .1 One set of full size white printed Division 21, 22, 23 record drawings.
 - .2 One set of reduced size Division 21, 22, 23 record drawings bound in each Maintenance Manual.
 - .3 One set of full size sprinkler system record drawings at each Sprinkler Station. Refer to Division 21 Fire Suppression.

2.3 Balance Reports

- .1 Refer to Section 23 05 93.1 Testing, 23 05 93.2 Adjusting and 23 05 93.3 Balancing
- .2 Provide specified number of final copies for inclusion in Operating and Maintenance Manuals.

2.4 Permits

- .1 Refer to Section 23 05 93.1 Testing, 23 05 93.3 Adjusting and Balancing and Section 23 05 00, Common Work Results for HVAC.

2.5 Equipment Test Reports

- .1 Refer to Section 23 05 93.1 Testing and 23 05 93.2 Balancing.

2.6 Commissioning Reports

- .1 Refer to Section 23 05 93.1 Testing, 23 05 93.2 Balancing and Section 23 05 00, Common Work Results for HVAC.

3. EXECUTION

3.1 Maintenance Manuals

- .1 Substantial Performance cannot be declared until reviewed Manuals are in the hands of the Departmental Representative.
- .2 Submit a draft copy of proposed content, including comprehensive systems description, for approval prior to Substantial Performance.
- .3 Provide one corrected and final copy of the Maintenance Manual along with an electronic version (CD Read-Write or flash drive) of the maintenance manual, to the Departmental Representative at least five days prior to Substantial Performance.

3.2 Record Drawings

- .1 The contractor is to maintain on site a clean set of drawings to be used to mark on any changes made during the course of construction. Changes must be kept up to date on a daily basis.

1. GENERAL

1.1 Description of Work

- .1 The scope of this contract includes but is not limited to the provision and installation of:
 - .1 Heating, ventilating and air conditioning equipment and accessories.
 - .2 Hot water piping and accessories, new and renovated.
 - .3 Natural gas piping and accessories.
 - .4 Ductwork and accessories, new and renovated.
 - .5 Domestic water piping and accessories, new and renovated.
 - .6 Sanitary Drainage Piping and accessories, new and renovated.
 - .7 Vent piping and accessories, new and renovated.
 - .8 Plumbing fixtures and accessories.
 - .9 Controls and accessories.
 - .10 Renovation or removal of existing systems, services and equipment.
 - .11 New and Renovated automatic fire sprinkler system and accessories.
 - .12 Renovations, cutting and patching.
 - .13 Cutting and patching for wall and floor openings less than 150 mm in any dimension.
 - .14 Roof repair, roof curbs, and roof openings of any dimension.

2. PRODUCTS

2.1 Access Doors and Panels

- .1 Provide schedule and samples of access doors to Department Representative prior to installation. Improperly located or sized access to equipment shall be corrected prior to final inspection.
- .2 Provide access doors for maintenance of adjustment purposes for all mechanical system components including, but not limited to:
 - .1 Valves.
 - .2 Volume dampers.
 - .3 Fire dampers.
 - .4 Cleanouts and traps.
 - .5 Controls, coils and terminal units.
 - .6 Turning vanes.
- .3 Access doors shall:
 - .1 Have flush type steel framed panel with concealed hinges.
 - .2 Be brushed 14-gauge stainless steel in ceramic tiled surfaces, recessed tile bearing type in vinyl tiled or carpeted surfaces, and prime coat in plastic or drywall surfaces unless otherwise directed.
 - .3 In concrete, stonework or terrazzo tile surfaces, provide heavy flush nickel plated cast bronze access covers.
 - .4 Fire rated construction shall have ULC rated doors compatible with construction.
 - .5 Cam type locking device, with Allen key operator.
 - .6 Minimum 300 mm x 300 mm for inspection and hand access.
 - .7 Minimum 450 mm x 600 mm for man access.

- .8 Provide locked access doors located in public corridors and washrooms complete with master keys.
- .9 Access doors to turning vanes, need only be a patch of similar gauge galvanized sheet metal secured to the duct and sealed with approved sealing compound.

2.2 Accessibility and Location of Equipment & Fixtures

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Install all work so as to be readily accessible for adjustment, operation and maintenance. Furnish access panels where required in building surfaces for installation by building trades.
- .4 Locate access panels in service areas wherever possible. Do not locate in panelled or special finish walls, without prior approval.
- .5 If any doubt exists, inform Departmental Representative of impending installation and obtain his approval for actual location.

2.3 Alternative Products or Systems

- .1 Where a list of acceptable materials, equipment or suppliers is included in this Division of the specification, Tenders are to be based on use of the specified equipment or equipment included in the acceptable materials clauses.
- .2 Where no list of acceptable materials, equipment or suppliers is included in the specification sections, Tenders are to be based on use of the specified materials, equipment or suppliers or any other material that complies with the specifications for quality, certification, material, performance, etc. A request for approval to supply alternative materials, equipment or suppliers is not required.
- .3 Request to have alternative materials, equipment or suppliers added to the list of acceptable materials, equipment or suppliers will be considered. Submit proposals to supply alternative materials, equipment or suppliers of equipment in writing, to the Department Representative at least seven days, unless otherwise noted, prior to Tender Closing Date for Divisions 21, 22, 23 and 25.
- .4 Materials or equipment alternatives: Identify specific materials or equipment for which alternates are requested. Provide specific technical data indicating dimensions, performance, weight, size, arrangement, etc. and other data as necessary or requested.
- .5 Suppliers or contractor alternatives: Provide references, project history, technicians qualifications, etc. and other data as necessary or requested.
- .6 Where specified equipment is included in a schedule, the request for approval must include an identical schedule, with each value of the alternate equipment compared to the specified equipment value. Photo copied schedules, marked with the alternate characteristics, would be acceptable.
- .7 All costs, including fees for re-design and record document correction, required to adapt alternative materials, equipment or suppliers shall be the responsibility of the Contractor.
- .8 Addition of materials, equipment or supplier's to the specifications will be by written addendum only.

2.4 Drives, Guards and Accessories

- .1 Provide guard for every new exposed coupling constructed of heavy gauge diamond mesh wire screen welded to steel angle frame. Prime coat.

- .2 Secure guards to driven machine, foundations or floors with heavy angle supports and anchor bolts. Do not short circuit vibration isolators.
- .3 Provide for movement of motor to adjust belt tension. Make provision for lubrication, use of tachometer, other maintenance and testing operations with guard in place.

2.5 Electrical Motors

- .1 Supply mechanical equipment complete with electrical motors. Motors provided under this Division shall have the characteristics as herein described.
- .2 Provide motors to CMA and CSA Standards for hard, continuous service, designed to limit temperature rise to 40°C for open housing and 50°C for drip proof housing and operate at 1200 or 1800 r/min. unless otherwise specified.
- .3 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 746 watts (1 hp) and 149.2 kw (200 hp), whether in packaged equipment or not, shall comply with the current requirements of the British Columbia Energy Efficiency Standards Regulation, and specifically, CSA C390-93 Energy Efficiency Test Methods for Three Phase Induction Motors.
- .4 For other three phase motors totally enclosed fan cooled, or ordinary drip proof motors provide energy efficient type motors with full-load efficiencies next step better than those listed in the following table:

Full Load		Full Load	
HP	Efficiency	HP	Efficiency
1.0	82.5	7.5	89.5
1.5	84.0	10.0	89.5

- .5 Motors shall have permanently lubricated ball or roller type bearings.
- .6 Refer to Division 16, Electrical for exact voltage, phase, requirements of electrically driven mechanical equipment, but generally motors shall follow this schedule.
 - .1 For motors up to and including 373 watts (1/2 HP) 120/1/60.
 - .2 For motors 560 watts and over, (3/4 HP) 208/3/60.
- .7 Provide all motors with terminal boxes, suitable for power connections.
- .8 Select motors for centrifugal fan applications, which are capable of being automatically cycled at 10 minute intervals.
- .9 Unless otherwise noted, starters and protection devices will be included under the Electrical Division of the Specification.
- .10 Motors less than 740 watts (1 hp) are to be provided with internal thermal motor protection feature.
- .11 Motors exposed to outdoor temperatures shall be lubricated with lubricants suitable for operation at -30 degrees C.
- .12 Assist the electrical trade to ensure proper connection, correct thermal overload selection and correct start/stop controls. Verify all motor voltages with electrical trade prior to operation.
- .13 Where starters are included in this Division of the Specification, they shall contain thermal overload protection in all ungrounded lines.
- .14 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch, supplied under this Division.

2.6 Materials and Equipment

- .1 Material and Equipment:
 - .1 Use new material and equipment unless otherwise specified.

- .2 Provide material and equipment of specified design and quality, performing to published ratings and for which replacement parts are readily available.
- .3 Use products of one manufacturer for equipment or material of same type or classification unless otherwise specified.
- .4 All Equipment and materials shall conform to the requirements of ASHRAE 90.1.
- .2 Manufacturer's Instructions:
 - .1 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.
 - .2 Notify Departmental Representative in writing of any conflict between these specifications and manufacturer's instructions. Departmental Representative will designate which document is to be followed.
- .3 Fastenings, General:
 - .1 Provide metal fastenings and accessories in same texture, colour and finish as base metal in which they occur. Prevent electrolytic action between dissimilar metals. Use non-corrosive fasteners, anchors and spacers for securing exterior Work.
 - .2 Space anchors within limits of load bearing or shear capacity and ensure that they provide positive permanent anchorage. Wood plugs not acceptable.
 - .3 Keep exposed fastenings to minimum, space evenly and lay out neatly.
 - .4 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.
 - .5 Explosive actuated fastening devices shall comply with CSA Z166.
- .4 Fastenings, Equipment:
 - .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
 - .2 Use heavy hexagon heads, semi-finished unless otherwise specified. Use No. 304 stainless steel for exterior areas.
 - .3 Bolts may not project more than one diameter beyond nuts.
 - .4 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur and resilient washers with stainless steel.
- .5 Delivery and Storage:
 - .1 Deliver, store and maintain packaged material and equipment with manufacturer's seals and labels intact.
 - .2 Prevent damage, adulteration and soiling of material and equipment during delivery, handling and storage. Immediately remove rejected material and equipment from site.
 - .3 Store material and equipment in accordance with supplier's instructions.
 - .4 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use primer or enamel to match original. Do not paint over name plates.

3. EXECUTION

3.1 Balancing, Commissioning and Documentation

- .1 The Balancing, Commissioning and Documentation work will be performed by this contractor under direction from the Commissioning Authority.
- .2 Record Drawings: The contractor is to maintain on site a clean set of drawings to be used to mark on any changes made during the course of construction. Changes must be kept up to date on a daily basis. Turn over drawings to Departmental Representative at Substantial Completion.

- .3 Maintenance Manual Materials: Turn over 3 paper copies and electronic copy of all maintenance materials to Departmental Representative's Documentation agent prior to substantial completion. These documents are to include but not limited to:
 - .1 Permits.
 - .2 Equipment start up reports.
 - .3 Chlorination report for water mains.
 - .4 Warranties, certificates and miscellaneous reports.
 - .5 Manufacturers' operating and maintenance brochures, and shop drawings, including wiring diagrams, fan performance data, pump curves with the operating point indicated, and control maintenance bulletins.
 - .6 Plumbing Fixture Brochure.
 - .7 Filter type, specification, model number, efficiency rating, and thickness; correlated with air handling equipment identification.
 - .8 Statutory inspection details.
 - .9 Control device setting record sheets.
 - .10 Instructions for emergency operation, maintenance and shutdown of all systems.
 - .11 Training Records.

3.2 Certificates & Transcripts

- .1 Submittals prior to start of construction:
 - .1 Certified copy of Insurance required to be provided by the Contractor.
 - .2 Letter of compliance with WorkSafeBC.
 - .3 Building permit compliance.
 - .4 Submittals as required elsewhere in this specification.
- .2 Submittals prior to initial progress claims:
 - .1 Cost breakdown.
 - .2 Submittals as required elsewhere in this specification.
- .3 Submittals during construction:
 - .1 Contractor's Statutory Declaration, on forms approved by C.C.A. is to accompany all progress claims subsequent to initial claim. Declaration is to certify that all past claims have been paid as certified or as noted and must be properly signed and notarized.
 - .2 Submittals as required elsewhere in this specification.
- .4 Submittals prior to Substantial Performance:
 - .1 Occupancy Permit and Inspection Certificates from authorities having jurisdiction and as required for equipment items to comply with governing Codes and Regulations.
 - .2 Operation and maintenance manuals.
 - .3 Record drawings.
 - .4 Results of all Tests required by the specification.
 - .5 Refer to Substantial Performance in this Section.
 - .6 Refer to Agreement GC 5.4 and GC 5.5.
 - .7 Submittals as required elsewhere in this specification.
- .5 Submittals at Total Performance:
 - .1 Refer to Project Close-out in this Section.
 - .2 Refer to Agreement GC 5.7.

- .3 Submittals as required elsewhere in this specification.

3.3 Changes and Clarifications to the Contract

- .1 During tender period: Errors, omissions or any questions regarding this Project must be referred to the Departmental Representative for clarification or correction not later than five working days prior to the Tender Closing Date. Any corrections or changes necessary to the Tender Documents will be contained in an Addendum issued by the Departmental Representative. All such corrections or changes confirmed by Addendum shall become part of the Tender Documents and their effect shall be included in the Tenderer's Contract Price. No extras will be permitted for elements of the Project which may be reasonably inferred from the Tender Documents to complete the Project. No proposed changes to the Contract, verbal or otherwise, shall be considered valid unless they are also included in a written addendum.
- .2 After tenders have been submitted, but prior to award of contract: Any corrections or changes necessary to the Tender Documents will be contained in a Post Tender Addendum issued by the Departmental Representative. Submit the cost for each change itemized in the Post Tender Addendum. Changes will not be considered part of the Contract unless confirmed in the letter of intent.
- .3 During the course of construction, after award of the Contract: Any corrections, changes or clarifications necessary to the Contract Documents will be contained in either a Change Notice, a Change Order, a Change Directive, or a Site Instruction issued by the Departmental Representative. No proposed changes to the contract, verbal or otherwise, shall be considered valid unless they are also included in a written Change Directive or Change Order.
 - .1 Change Notice: All Change Notice items are contemplated changes. Work is not to proceed until authorized by a Change Order. All materials and workmanship are to be as described in the contract documents unless otherwise stated. Provide a price for each item, including materials and labour breakdown. Provide further breakdowns as directed by the Departmental Representative. Indicate any change to the time of completion that will result from acceptance of the Change Notice items.
 - .2 Change Order: Change Order items refer to Change Notice items that have been accepted and become part of the contract. The work is to proceed at the agreed upon price, which will be attached to the Change Order.
 - .3 Change Directive: All Change Directive items become part of the contract. The work described shall proceed on a time and materials basis. Time and material costs must be submitted to the Departmental Representative for review. Provide further breakdowns as directed by the Departmental Representative.
 - .4 Site Instruction: All Site Instruction items are to be considered as clarifications to the contract, and not as additional work. No change to the Contract Price or time of completion will be accepted.

3.4 Codes and Standards

- .1 The work, including all materials, labour and other services shall conform, but not be limited to the requirements of the latest editions of the following Codes, Bylaws, Standards and Regulations:
 - .1 British Columbia Building Code.
 - .2 British Columbia Fire Code.
 - .3 Local Building Bylaws.
 - .4 WorkSafeBC.
 - .5 Canadian Standards Association.
 - .6 British Columbia Plumbing Code.
 - .7 Canadian Electrical Code.

- .8 CSA B149.1 Natural Gas and Propane Installation Code.
- .9 National Fire Protection Association.
- .10 Provincial Boiler Inspection Department.
- .11 National Board Inspection Code – Boiler and Pressure Vessel
- .12 Other relevant codes as noted in each individual specification section. Note the most stringent code will apply.

3.5 Concealment

- .1 Conceal all piping, ductwork and conduit in partitions, walls, crawl spaces and ceiling spaces unless otherwise noted.
- .2 Do not install piping and conduit in outside walls or roof slabs unless otherwise directed, in which case install them with the building insulation between them and the outside face of the building.

3.6 Contract Breakdown

- .1 After tenders close, submit a breakdown of contract price into divisions to the satisfaction of the Departmental Representative with aggregate of breakdown totalling total contract amount. Breakdown will be used in computing of progress claims. Progress claims, when submitted, are to be itemized against each item of the contract breakdown.
- .2 Progress claims will not be approved unless broken down in a form approved by the Department representative. A typical format is as follows:
 - .1 Miscellaneous Mobilization
 - .2 Testing & Balancing
 - .3 Commissioning
 - .4 Manuals and Documentation
 - .5 Record drawings
 - .6 Chemical Treatment
 - .7 Pipe and Pipe Fittings
 - .8 Vibration Isolation
 - .9 Insulation
 - .10 Plumbing Rough in
 - .11 Plumbing Fixtures and Trim
 - .12 Fire Protection
 - .13 HVAC Equipment
 - .14 Ductwork
 - .15 Controls
 - .16 Cash Allowances
 - .17 Change Orders with Divisions 21, 22, 23 and 25 Change Notice reference.
- .3 Progress claims for major systems or equipment will not be approved to 100% status until after complete commissioning and testing of the systems or equipment. This includes, but is not limited to systems such as boilers, heat pump systems control systems, heat exchangers, chemical treatment. At the contractors option, such systems or equipment may be identified as separate line items to allow approval of other sections of the work that have been completed.

3.7 Cutting and Patching - Renovation

- .1 Execute cutting, fitting and patching required to make Work fit properly together.

- .2 Making good is defined as matching the adjacent surfaces such that there be no visible difference between existing and new surfaces when viewed from 1.5 m in the ambient light, and includes painting the whole surface to the next change of plane.
- .3 Obtain Departmental Representative's approval before cutting, boring or sleeving load-bearing members.
- .4 Make cuts with clean, true, smooth edges. Make patches inconspicuous in final assembly.
- .5 Fit work airtight to pipes, sleeves, ducts and conduits.
- .6 At penetrations of fire rated assemblies, with any services or ducts completely seal voids with approved fire resistive material, for the full thickness of the construction element and to comply with Code requirements.
- .7 Before cutting or coring existing concrete slabs, X-ray locations to ensure that there are no concealed services or structural elements such as rebar.

3.8 Demolition of Existing Systems and Equipment

- .1 Remove all identified equipment and systems complete with controls, mounting devices, electrical connections, control connections, mechanical services, gas connection, domestic water connection, hydronic water connection, etc.
- .2 Cut and cap services at the nearest main. Do not leave dead legs.
- .3 Where existing service is insulated, provide equivalent insulation at the capped location. Ensure that new and existing insulation is continuous and that the vapour barrier is intact.
- .4 Do not abandon equipment or systems in place unless otherwise indicated.
- .5 Patch and make good any building elements damaged by demolition work. This includes mounting points.

3.9 Demonstration Instruction to Departmental Representative

- .1 Demonstrate to and instruct representatives designated by the building operator on the complete systems operating and maintenance procedures using the assistance of specialist sub trades and manufacturers' representatives.
- .2 Allow for a minimum of 1 full day for demonstration.
- .3 Participate in, and aid the Commissioning Agent in, the Commissioning and Demonstration process for each system. Demonstration and training sessions will be convened separately for each piece of equipment and each individual system.
- .4 Submit a program for approval. When approval is obtained from the Commissioning Authority, arrange an acceptable time for the instruction periods.
- .5 Obtain a signed statement from the Departmental Representative certifying that the demonstration and instruction have been given to his satisfaction.
- .6 Obtain a list of all persons attending commissioning, demonstration, or training sessions, including their signatures and job title.

3.10 Documents Required

- .1 Maintain at job site, one copy of each of the following:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Reviewed shop drawings.
 - .5 Change Orders.
 - .6 Other modifications to Contract.

- .7 Field test reports.
- .8 Copy of the Construction Schedule.
- .9 Manufacturer's installation and application instructions.
- .10 Standards listed in Part 1 of specification sections under codes and standards.

3.11 Drawings and Measurements

- .1 Drawings are generally diagrammatic and intended to indicate the scope and general arrangement of work. Do not scale the drawings. Take field measurements where equipment and material dimensions are dependent upon building dimensions.
- .2 Review all drawings and documents for all trades on the project. Coordinate work specified in this Division with that of other Divisions. Advise other trades of requirements specified in this Division, and how those requirements affect the other trades.
- .3 Consult the Architectural, Structural, Electrical, and all other drawings and details for exact locations of fixtures and equipment, mechanical and otherwise. Obtain this information from the Departmental Representative where definite locations are not detailed.

3.12 Departmental Representative Approval

- .1 It is not incumbent upon the Departmental Representative to superintend the work so as to relieve the Contractor of any responsibility.
- .2 Permission to proceed does not constitute approval of the work, or portion thereof.
- .3 Approval of the work shall be made only upon the successful conclusion of tests and satisfactory performance under design operating conditions.

3.13 Equipment Protection Cleanup

- .1 Protect equipment and materials in storage and on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
- .2 Protect equipment with polyethylene covers and crates.
- .3 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.
- .4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion.
- .5 Cover and protect all floors, furniture, millwork, computers, servers and other information technology equipment. Coordinate with the Departmental Representative to remove any equipment that is at risk and cannot be protected.

3.14 Excavation and Backfill

- .1 Refer to requirements of Division 2.
- .2 Excavation is specified under other Divisions.
- .3 Provide bedding and backfill with sand or other approved material to minimum of 150 mm over pipe or as necessary to protect mechanical work. Remainder of backfilling, compaction and disposal of surplus material shall be as specified in other Sections.

3.15 Existing Utilities

- .1 When breaking into or connecting to existing services or utilities, carry out work at times directed by local governing authorities, with a minimum of disturbance to work and/or building occupants and pedestrian and vehicular traffic. Notify Designated Representative at least 24 hours before carrying out such work.

- .2 Protect, relocate or maintain existing active services as required. When inactive services are encountered, cap off in a manner approved by local governing authorities having jurisdiction and stake or otherwise record location of capped service.

3.16 Gas Inspection

- .1 Submit to the Provincial Gas Inspection Department, drawings, applicable sections of specifications and detailed drawings as required to obtain approval for the gas installation.

3.17 Handover of New or Renovated Systems

- .1 Prior to Substantial Performance, some new or renovated sections of the building may be re-occupied by the building operator for normal operations. When new or renovated mechanical systems are activated for service on sections of the building being re-occupied, the systems must be formally handed over to the Departmental Representative.
- .2 Subject to the Departmental Representative accepting these reactivated systems, the Departmental Representative will assume responsibility for normal maintenance such as filter changes, lubrication, etc.

3.18 Identification and Labelling

- .1 Equipment and panels: Provide engraved plastic identification plates for the following items:
 - .1 Control panels.
 - .2 Electrical devices supplied under this Division of the Specification.
 - .3 All equipment provided under this Division.
 - .4 Refer to Section 25 01 05, Controls.
- .2 Ducts and pipes: Label with 25 mm high black letters on a white background on the following items, after painting is complete. Use stencil or pressure sensitive tape labels.
 - .1 All pieces of equipment supplied under this Division.
 - .2 Duct runs, pipe runs including zone heads. Identify system and/or zone. Identify at 15 meter intervals or less, as required.
 - .3 Gas piping: not more than 6.0 metre intervals, at change of direction, where passing through walls and ceilings, or entering or leaving other concealed space.
 - .4 Non-Potable Water piping: not more than 6.0 metre intervals, at change of direction, where passing through walls and ceilings, or entering or leaving other concealed space.
 - .5 Piping system label abbreviations must match the Existing building system.
- .3 Temporary equipment labels: Until permanent equipment labels have been installed, provide temporary labeling for use during course of construction to aid site coordination. Temporary labeling shall be completed once equipment has been uncrated and prior installation. Temporary labels shall be either removed or hidden once permanent labels are installed.
- .4 Where services are installed above suspended ceilings, or behind access doors, secure self-adhesive coloured dots to the access door or ceiling T-bar member, to identify the location of access to equipment concealed. To indicate exactly which tile or panel has to be removed, the coloured dots should be placed on two of the bars adjacent to the subject tile.
- .5 Provide coloured circular stickers, minimum 12mm diameter, to identify access locations for mechanical equipment and services. The access shall be identified in accordance with the colour schedule shown below:

Item	Colour
Fire Damper	Red
Cleaning Access	Black
Dampers (auto or back draft)	Dark Green
Balancing Dampers	Dark Green
Filter	Brown
Sprinkler Test Valve	Light Green
Control Device - Controller	Dark Blue
Control Relay Cabinets	Yellow
Controls Device - General	Orange

3.19 Intent

- .1 Provide complete and fully operational mechanical systems with facilities and services to meet requirements described herein and in complete accord with applicable codes and ordinances.
- .2 Follow manufacturer's recommended installation details and procedure for equipment supplemented by the contract documents
- .3 Install equipment in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment.
- .4 Provide labour and materials required to install, test and place into operation on the mechanical systems. Provide additional material for modifications required to correct job conflicts.
- .5 The word "provide" shall mean "supply and install" unless otherwise indicated.
- .6 In the event of a disagreement between the drawings and specifications, the specifications shall take precedence.
- .7 Any reference to the Department Representative in this Division shall mean Smith + Andersen.
- .8 The main divisions of the work of this Division generally includes the supply and installation of the following:
 - .1 Heating, Ventilating, Air Conditioning Systems.
 - .2 Exhaust and Ventilation Systems.
 - .3 Plumbing Systems.
 - .4 Equipment Control Systems.
 - .5 Fire Protection Systems.

3.20 Location of Equipment & Fixtures

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Install all work so as to be readily accessible for adjustment, operation and maintenance. Furnish access panels where required in building surfaces for installation by building trades.
- .4 Locate access panels in service areas wherever possible. Do not locate in panelled or special finish walls, without prior approval.
- .5 If any doubt exists, inform Departmental Representative of impending installation and obtain his approval for actual location.

3.21 Miscellaneous Metal

- .1 Be responsible for all miscellaneous steel work relative to Divisions 21, 22, 23 and 25 of the Specifications, including but not limited to:
 - .1 Support of equipment.
 - .2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork fans and mechanical equipment.
 - .3 Pipe anchor and/or support posts.
 - .4 Ceiling ring bolts - secure to structure or steel supports.

3.22 Building Operator Occupancy

- .1 The building operator will occupy the premises during the entire period of construction for the conduct of his normal operations. It is mandatory to cooperate with the building operator in all construction operations to minimize conflict, and to facilitate the building operator's continued and uninterrupted usage.
- .2 Schedule work so as not to disturb, disrupt, or endanger building occupants or normal facility operations. Coordinate work with the Departmental Representative.
- .3 Provide 48 hours' notice to the Designated Representative prior to disruption of systems. Obtain approval prior to proceeding with systems shutdown or disruption.
- .4 Provide temporary work as required to maintain systems in operation at all times. Short periods of discontinuous service may be approved for reconnection, modification or renovation of services or systems.
- .5 The Departmental Representative may instruct the contractor to activate systems in the area of work even if the remainder of the construction and installation of building components is not complete. The Contractor must schedule his work to allow minimal periods of inoperable system operation in the area of work.

3.23 Permits and Fees

- .1 Unless otherwise specified, give all necessary notices, obtain all necessary permits, and pay all fees in order that the work may be carried out.
- .2 Furnish any certificates necessary and evidence that the work installed conforms with regulations of all authorities having jurisdiction before final certificates are issued.

3.24 Prior Tests and Inspections

- .1 Test all work prior to concealment.
- .2 Notify the Departmental Representative of the requirements for inspections or tests with forty-eight hours' notice.
- .3 If instructed by the Departmental Representative, material installed under this Division and covered before approval, must be exposed or uncovered at contractor's cost for the necessary inspection.

3.25 Project Coordination

- .1 Coordinate progress of the Work, progress schedules, submittals, use of site, temporary utilities and construction facilities.
- .2 All Contractors are required to perform an on-site examination prior to commencing Work and notify the Departmental Representative of any deviation from the Contract Documents. Commencement of Work shall indicate acceptance of existing conditions.
- .3 The responsibility as to which sub-trade supplies and installs any and all materials rests solely with the Prime Contractor.

- .4 Extras to the Contract will not be considered based on grounds of difference in interpretation of plans and specifications as to which trade involved shall be responsible for certain materials, installation or specialties.
- .5 The Contractor shall do all cutting and remedial Work that may be required to make several parts of the Work come together properly. Coordinate the schedule to ensure that as much as possible is built into the Work and that this requirement is kept to a minimum.

3.26 Project Meetings

- .1 Attend project meetings as detailed in Division 1.

3.27 Protective Coatings and Painting

- .1 All exposed steel piping, hangers, supports, brackets, stands and other miscellaneous metal and uncoated steel surfaces which is supplied under this Division are to be prime coated. Ceiling spaces, pipe shafts, and crawl spaces are not considered exposed.
- .2 Finish painting of all equipment and material installed under this Division is specified under Division 9 of the specification, unless specified otherwise.
- .3 Apply one coat of galvanizing paint to all steel which has had its galvanized coating damaged or sheared.

3.28 Record Drawings

- .1 Keep on site, an extra set of drawings and specifications recording changes and deviations daily.
- .2 Include all details from revision drawings, supplementary drawings, change order and addenda.
- .3 Before Substantial Completion submit for approval to the Department representative, completed and detailed marked up white prints to reflect the record drawing status.
- .4 Contractors shall certify final reproducible record drawings to be correct by notation and signature.
- .5 The Departmental Representative will provide services for the following:
 - .1 Updating the original computer software to include all changes recorded on the record white prints.
 - .2 Plotting one set of full size reproducible record drawings.
 - .3 Plotting one set of reduced size reproducible record drawings.
 - .4 Photocopying three sets of reduced sized record drawings.
- .6 After the contractor certifies and signs the completed record drawings, the contractor shall provide with each Maintenance Manual, the following record materials provided under the Cash Allowance.
 - .1 One set of full size record drawings attached with each Manual.
 - .2 One set of reduced size record drawings bound in each Manual.
- .7 After the contractor certifies and signs the completed record drawings, the contractor shall submit or distribute the following record materials provided under the Cash Allowance.
 - .1 One set of full size reproducible record drawings to the Department representative.
 - .2 One set of full size sprinkler system record drawings at each Sprinkler Station. Refer to Division 21 Fire Suppression.
 - .3 One set of full size sprinkler system record drawings to the Departmental Representative's Insurance Company. Refer to Division 21 Fire Suppression. Attach with other specified submittals.

3.29 Responsibility

- .1 Check drawings of all trades to verify space and headroom limitations for work to be installed. Coordinate work with all trades and make changes to facilitate a satisfactory installation. Make no deviations to the design intent involving extra cost to the Departmental Representative without written approval.
- .2 Promptly advise the Departmental Representative of any specified equipment, material, or installation of same which appears inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; of any necessary items of work omitted from the Contract Documents; or of any discrepancies in the Specifications.
- .3 When the Contract Documents do not contain sufficient information for proper selection or bidding, notify the Department Representative during the tendering period. Failure to do this shall not relieve the Contractor of responsibility to supply the intended equipment.
- .4 The Contractor is to consider that this is a renovation project. Reasonable allowances must be included for refitting or relocation of services and components that may be discovered during the course of construction that were not apparent at the commencement of the project, shown on plans, or concealed in walls, ceilings or floors. Necessary accessories for connection and modifications of configurations or materials shall be included at no extra cost to the Departmental Representative.

3.30 Separate Prices

- .1 Refer to Division 01

3.31 Setting Out of Work

- .1 Assume full responsibility for and execute complete layout of Work to locations, lines and elevations indicated. Provide devices needed to lay out and construct Work.
- .2 Exercise proper precautions to verify figures shown on the drawings, before laying out of work, and be responsible for any errors resulting from failure to exercise such precautions.
- .3 The drawings indicate the general location and route to be followed by the pipes and ducts, etc. Install so as to conserve headroom and interfere as little as possible with the free use of the space through which they pass. Keep all ducts, pipes, etc. at the ceilings as tight as possible to beams or other limiting members. Where headroom or space conditions appear inadequate, notify the Departmental Representative before proceeding with fabrication and/or installation.
- .4 Ensure non-interference between heating, plumbing, drainage, electrical and other equipment.
- .5 Make any corrections required in order to avoid the work of other trades, and/or as required by the Departmental Representative.
- .6 Maintain integrity of fire separations and compartments.

3.32 Shop Drawings, Product Data and Samples

- .1 Shop drawings must be submitted and reviewed by the Departmental Representative prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.
- .2 **Shop drawings shall be submitted in S.I. (Metric) Units. Shop drawings not submitted in the correct units may be automatically returned without review.**
- .3 Submit materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Department representative's office. Maintenance and operating manuals are not suitable submittal material.

- .4 Review of the shop drawings by the Departmental Representative does not relieve the contractor or his supplier of the responsibility to provide the correct and complete equipment, material or installation.
- .5 Prior to submission to the Department representative, the Contractor shall review all shop drawings. By this review the Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data or will do so and that he has checked and coordinated each shop drawing with the requirements of the Work and of the Contract Documents.
- .6 The Contractor's review of each shop drawing shall be indicated by his approval stamp, date and signature on the front of each page. Drawings will not be considered if not previously checked by the Contractor.
- .7 Clearly mark each sheet of printed submittal material, using arrows, underlining or circling, to show particular sizes, dimensions, wiring diagrams, operating clearances, control diagrams, project identification, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable material. Note on the submittal specified features such as special tank linings, pump seals, materials or painting.
- .8 The contractor shall identify in writing, on the shop drawings, all aspects, accessories, options etc. that do not conform to the tender documents. Failure to do so will result in work being rejected.
- .9 The mechanical contractor and the general contractor shall each review the shop drawings then stamp and initial the front page of each submission package and sign the original transmittal form. The contractor's shop drawing review shall include a detailed review of all installation details to ensure that they do not conflict with other trades, and to ensure that the system can be installed as intended.
- .10 **Submit ONE reproducible copy or PDF version** of each shop drawing and all supporting material, sufficiently in advance of requirements to allow time for review. Reproducible means photocopy capable for small sheets up to 280 mm by 430 mm (11 inches by 17 inches). Larger sheets shall be printed full scale.
- .11 Where colour is criterion, submit full range of colours.
- .12 Schedule submissions with adequate lead time for review by all concerned parties before the dates when reviewed submissions are required for ordering of equipment.
- .13 Coordination of Submissions:
 - .1 Coordinate with field construction criteria.
 - .2 Coordinate each submittal with requirements of the work of all trades and Contract Documents.

3.33 Site Assessment

- .1 Refer to Division 0 and Division 1.
- .2 Visit the site before tendering and examine all local and existing conditions on which the work is dependent.
- .3 No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit the site or insufficient site examination.

3.34 Sleeves, Hangers, and Inserts

- .1 Provide and set sleeves where conduits pass through walls, floors or ceilings. Pack sleeves with material approved for use in fire separations.
- .2 Obtain Departmental Representative's approval before cutting for sleeves.
- .3 Provide and install hangers and inserts where required.

3.35 Substantial Performance Procedure

- .1 Prior to the Substantial Performance Inspection, provide complete list of items which are not finished or deficient at the time of the inspection.
- .2 Provide all required submittals in a timely fashion prior to requesting substantial performance review. Confirm the required documentation with the Department representative.
- .3 Final cleaning:
 - .1 Make the work area clean before the inspection process commences.
 - .2 Clean and polish finish surfaces.
 - .3 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls and ceilings.
 - .4 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
 - .5 Broom clean and wash exterior walks, steps and surfaces.
 - .6 Remove dirt and other disfigurations from exterior surfaces.
 - .7 Final clean-up of existing premises shall only be performed in areas where alteration work has been performed.
- .4 Demonstration and Inspection to Departmental Representative:
 - .1 Refer to Section 23 05 93.1 Testing, 23 05 93.2 Balancing, 23 05 93.3 Commissioning, 23 01 00 Documentation, Manuals and Record Drawings.
 - .2 Prior to Substantial Performance, demonstrate to and instruct the Departmental Representative on the complete systems operating and maintenance procedures using the assistance of specialist sub-trades and manufacturer's representatives.
 - .3 Submit a program for approval to the Departmental Representative. When approval is obtained from the Departmental Representative, arrange an acceptable time for the instruction periods.
 - .4 Obtain a signed statement from the Departmental Representative certifying that the demonstration and instruction have been given to his satisfaction.
- .5 Completion of Phase 4 Commissioning to be complete prior to substantial performance. Refer to 23 05 93.3 Commissioning.
- .6 Prior to application for Certificate of Substantial Performance, carefully inspect the Work and ensure it is complete, that major and minor construction deficiencies are complete, defects are corrected and the building is clean and in condition for occupancy.
- .7 Notify the Departmental Representative in writing that the project is ready for inspection for Substantial Performance.
- .8 During the Substantial Performance Inspection a list of deficiencies and defects will be tabulated.
- .9 A deficiency holdback will be established as specified. This holdback shall be retained until all items on the deficiency list are completed. No interim payments will be released.
- .10 Deficiency items shall be confirmed completed by all parties prior to Total Performance.
- .11 Should the Departmental Representative perform re-inspection due to failure of the Work to comply with the claims of status of completion made by the Contractor:
 - .1 Building operator will compensate the Departmental Representative for such additional services.
 - .2 Building operator will deduct the amount of such compensation from the final payment to the Contractor.
- .12 Submittals: As required, including but not limited to requirements specified in this section.

3.36 Taxes

- .1 Pay all taxes levied by law, including Federal, Provincial, Municipal and Goods and Services Taxes.
- .2 Goods and Services Tax is to be shown as a separate item on all progress claims.

3.37 Temporary Facilities

- .1 The Contractor shall provide the following temporary services and connections.
- .2 Heating and Ventilating:
 - .1 When the EF- 2 is relocated, provide a temporary exhaust fan at the building warehouse entrance to allow for exhaust removal during use Fan should be approximately 3,500 l/s at 95Pa static pressure. The fan will be manually operated if air quality in the warehouse is compromised.
 - .2 Maintain existing space environment to conditions acceptable to the Departmental Representative and the occupiers of the building.
 - .3 When permanent heating system is in operable condition, it may be used for heating the building prior to the final inspection, upon written approval from the Departmental Representative who will require cleaning, maintenance and conditioning of the complete system prior to Substantial Performance.
 - .4 Pay for costs of temporary heat and ventilation required for construction purposes including costs of installation, fuel, operation, maintenance and removal of equipment.
 - .5 Use of direct fired heaters discharging waste products into occupied or work areas will not be permitted.
- .3 Removal of Temporary Facilities:
 - .1 Remove temporary facilities from site when directed by Departmental Representative.

3.38 Temporary Heat

- .1 Refer to Division 1.
- .2 Do not use the permanent system for temporary heating purposes, during the construction period, without written permission from the Department representative.
- .3 Thoroughly clean and overhaul permanent equipment used during the construction period, replacing worn or damaged parts. Exchange equipment or components operating improperly at final inspection with new equipment or components.
- .4 Use of permanent systems for temporary heat shall not modify the terms of the warranty for all systems and equipment as specified elsewhere.
- .5 Operating heating systems under conditions which ensure no temporary or permanent damage. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate water systems with proper water treatment.
- .6 Where air systems are used during temporary heating, provide filter media on return and exhaust air inlets. Clean duct systems which have become dirty.

3.39 Temporary or Trial Usage

- .1 Temporary or trial usage by the building operator of mechanical equipment before Substantial Completion shall not represent acceptance.
- .2 Temporary use of mechanical systems and equipment for temporary heating service, either for construction or occupant benefit, before Substantial Completion shall not represent acceptance. Warranty periods shall not commence until the date of Substantial Completion.
- .3 Repair or replace permanent equipment used temporarily.

- .4 Take responsibility for damage caused by defective materials or workmanship during temporary or trial usage.

3.40 Time of Completion

- .1 Commence work immediately upon official notification of acceptance of Tender and complete the Work as stated in the Contract Documents.

3.41 Total Performance Inspections and Project Close Out

- .1 Prior to Total Performance provide a declaration, in writing, that deficiencies as noted on current Inspection Report are not outstanding.
- .2 Notify the Departmental Representative in writing that all deficiencies have been corrected and that the building is ready for Final Inspection.
- .3 Submit a final Statement of Account showing total adjusted Contract Price, previous payments and any other adjustments and monies due.
- .4 Submit a current Statutory Declaration.
- .5 Submit WorkSafeBC (Workers' Compensation Board) Certificate of Compliance.
- .6 Departmental Representative will issue a final change order reflecting approved adjustments to contract price not previously made.

3.42 Trades Qualifications, Competency Assurance, Licenses

- .1 All workers engaged in the construction or renovation of systems or equipment, shall be journeymen who have Trades Qualifications under Province of British Columbia legislation, or are indentured apprentices working under a journeyman who is on the site.
- .2 All workers engaged in the construction or renovation of systems or equipment governed by other agencies such as the Federal or Provincial Ministry of Labour, Ministry of Health or the Ministry of Environment shall be appropriately licensed under Federal or Provincial legislation.
- .3 Tradesmen shall perform only work that their certificate permits.
- .4 Trades Qualification certificates or other licenses must be submitted prior to commencing work and must be on site for inspection.
- .5 Trades Qualifications or certificates or competency or licenses must be carried for workers including, but not limited to the following:
 - .1 Plumbing
 - .2 Gas fitting
 - .3 Pipe fitting
 - .4 Pipe Insulation
 - .5 Duct Insulation
 - .6 Sprinkler Fitting
 - .7 Refrigeration
 - .8 Boiler installation
 - .9 Sheet Metal Work

3.43 Workmanship

- .1 Standards of Workmanship shall be in accordance with well-established practices and standards accepted and recognized by the Departmental Representative and the Trade.
- .2 Do not employ any unfit person or anyone unskilled in their required duties.
- .3 The Departmental Representative shall have the right to reject any item of work that does not conform to the Contract Documents and accepted standards of performance, quietness of operation, finish and acceptance.

3.44 Warranty

- .1 Refer to Division 0 and Division 1.
- .2 The warranty period with regard to the Contract, other than for latent defects, is limited to one year from the date of Substantial Performance of the Work unless otherwise specified.
- .3 Correct any defects in the work due to faulty products or workmanship appearing within the warranty period.
- .4 The warranty shall not apply to work or other products damaged after Acceptance, by causes beyond the Contractor's control such as lack of prescribed maintenance, vandalism and abuse.
- .5 Correct and pay for any damage to other work resulting from any correction required under these conditions.
- .6 In the event that the repair time of defective equipment or systems is delayed for whatever reason, maintain the equipment or system in an approved manner until repairs can be made.

1. GENERAL

1.1 Work Included

- .1 Renovations to existing sanitary drainage and vent piping.
- .2 Renovations to existing fuel system piping.
- .3 Renovations to existing domestic water piping.
- .4 Renovations to existing fire protection system piping.
- .5 Renovations to existing heating and chilled water system piping.
- .6 Refrigerant system piping.
- .7 Pressure and temperature relief piping.
- .8 Strainers.
- .9 Unions and mechanical couplings.

1.2 Welding

- .1 Welding materials and labour shall conform to ASME Code and the Provincial Regulations.
- .2 Use welders fully qualified and licensed by Provincial Authorities.

1.3 Quality Assurance

- .1 Domestic water, drainage and vent piping shall meet the requirements of the British Columbia Building Code, British Columbia Plumbing Code, and Municipal Codes.
- .2 Copper tube domestic water piping shall comply with the requirements of the British Columbia Building Code AND with the requirements of Standard ASTM B88_83a. All tubing shall be marked by the manufacturer as complying with this standard. This Division shall be responsible for any costs, including direct charges by the Department representative, for testing, inspection and certification required by the Authority having jurisdiction, to certify that copper tubing in domestic water systems meets all requirements of this specification and those of the Authority having jurisdiction.
- .3 Sprinkler light wall pipe shall be ULC listed, FM listed, manufactured to ASTM-A-135 NHA-300-PSI. Equal to Allied XL.
- .4 Roll form joint light wall sprinkler pipe shall be ULC listed, FM listed, manufactured to ASTM-A-795-A-ERW-NH-300-PSI. Equal to Allied Super Flo.
- .5 Sprinkler System piping shall meet the requirements of NFPA No. 13 Standard for the Installation of Sprinkler Systems.
- .6 Fire hose standpipe piping shall meet the requirements of NFPA No. 14 Standard for the Installation of Standpipe and Hose Systems.
- .7 Pipe fittings shall conform to the following standards:
 - .1 ANSI/ASME B1.20.1-1983 (Pipe Threads)
 - .2 ASTM-197-47 (Materials)
 - .3 ANSI B16.3-1977 (Dimensions)
 - .4 USAS B2.1-1968 (Pipe Threads)
 - .5 JIS B 2301-1988 (Screwed Type Malleable Cast Iron Pipe Fittings)
 - .6 JIS H 8641-1982 (Zinc Hot Dip Galvanizing)
 - .7 JIS G 5702-1988 (Blackheart Malleable Iron Castings)

1.4 Acceptable Manufacturers

- .1 Manufacturers of groove and clamp pipe fittings whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Victaulic.
- .2 Manufacturers of sprinkler pipe fittings whose products are approved in principle, but subject to the requirements of drawings and specifications are:
 - .1 Victaulic (V-brand) - malleable iron, ductile iron, steel

1.5 Submittals – Prior to Construction

- .1 Pipe Fittings: Submit one sample piece for each type of fitting including but not limited to screwed, welded or clamped elbows, tees, flanges and couplings.
- .2 Grooved coupling Gaskets: Full technical information including but not limited to material, service temperature, installation instructions, identification, compatibility with proposed coupling hardware, etc.
- .3 Mechanical Joint Couplings: Listed to CAN/ULC S102.2-10 & CSA-B602.

2. PRODUCTS

2.1 Pipe - Service & Material

- .1 Equipment Drains and Overflows:
 - .1 Material: Galvanized Steel Schedule 40
 - .1 Fittings: Galvanized - threaded
 - .2 Material: Type K or L Hard Copper
 - .1 Fittings: Wrought copper, cast brass - 50/50 solder
 - .2 Fittings: Cast brass - threaded
 - .3 Material: PVC schedule 40
 - .1 Fittings: PVC - solvent weld
- .2 Boiler Condensate Drains:
 - .1 Material: PVC schedule 40
 - .1 Fittings: PVC - solvent weld
- .3 Sanitary Drainage and Vent (above grade including crawlspace):
 - .1 Material: Type M or DWV Copper
 - .1 Fittings: Wrought copper, cast brass - 50/50 solder
 - .2 Material: Cast Iron
 - .1 Fittings: Mechanical joint
- .4 Sanitary Drainage and Vent (buried under building):
 - .1 Material: Cast Iron
 - .1 Fittings: Mechanical joint, hub and spigot
 - .2 Material: ABS Solid Core, PVC (CSA Approved)
 - .1 Fittings: ABS Solid Core, PVC - solvent weld
- .5 Domestic Water (above grade):
 - .1 Material: Type L Hard Copper
 - .1 Fittings: Wrought copper - lead free solder
 - .2 Fittings: Cast brass, bronze - threaded

- .6 Domestic Water (below grade):
 - .1 Material: Type K or Type L Soft Copper
 - .1 Fittings: Cast bronze - Flared tube
 - .2 Material: PVC SCM 150
 - .1 Fittings: Hub and spigot, thrust block at elbows, rod connection at end of line
 - .3 Material: Cast Iron
 - .1 Fittings: Hub and spigot, thrust block at elbows, rod connection at end of line
 - .4 Material: Non-metallic cross linked polyethylene (PEX) to CSA B137.5
 - .1 Proprietary compression joint.
 - .2 Below grade piping must be continuous and not have joints.
- .7 Fire Protection (above grade):
 - .1 64 mm and smaller:
 - .1 Material: Steel schedule 40
 - .2 Fittings: Forged steel - welded, flanged
 - .3 Fittings: Malleable steel - threaded, flanged, grooved mechanical coupling;
 - .2 75 mm and larger:
 - .1 Material: Steel Light wall - grooved mechanical, compression fit. Corrosion Resistance Rating equal to schedule 40 steel pipe.
- .8 Natural Gas (above grade):
 - .1 Material: Steel Schedule 40
 - .1 Fittings: Malleable steel - threaded under 63 mm if approved
 - .2 Fittings: Forged steel - welded 63 mm and over and where required by service
 - .3 Press type fittings are not permitted.
 - .4 Flexible corrugated piping of aluminum or any other material is not acceptable, except at the final connection to equipment.
- .9 Hot Water Heating to 120°C (250°F):
 - .1 Material: Steel Schedule 40
 - .1 Fittings: Malleable steel – threaded
 - .2 Fittings: Forged steel - welded, flanged
 - .3 Fittings: Grooved Mechanical Couplings
 - .2 Material: Type M Hard Copper
 - .1 Fittings: Wrought copper, cast bronze - 95/5 solder
 - .3 Material: Type M Soft Copper
 - .1 Fittings: Wrought copper, cast bronze - 95/5 solder
- .10 Relief valve piping – boiler
 - .1 Material: Steel Schedule 40
 - .1 Fittings: Malleable steel - threaded
- .11 Refrigerant:
 - .1 Material: ACR Copper Grade 2
 - .1 Fittings: Wrought copper - Brazed phoscopper alloy
 - .2 Fittings: Forged brass - brazed silver copper

2.2 Unions

- .1 Size 51 and under: 1035 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.
- .2 Sizes 64 mm and over: 1035 kPa (150 psi) forged steel slip on flanges for ferrous piping, 150 lb. bronze flanges for copper piping. Gaskets shall be 1.6 mm thick performed synthetic rubber bonded fibre material. Gaskets for gas service shall be synthetic rubber.

2.3 Grooved Mechanical Couplings

- .1 Only grooved pipe end type, non-reducing, bolted connection couplings are approved. Gasketed and set screw, non-bolted lever clamp, or jaw grip type couplings are not approved.
- .2 Fire protection systems must use couplings certified for use in fire protection systems, and must be listed by NFPA, FM and ULC.
- .3 Housing: Ductile Iron conforming to ASTM-A536 or Malleable Iron conforming to ASTN-A47.
- .4 Gasket: EPDM composition to suit temperature service requirements.
- .5 Bolts and Nuts: Heat treated carbon steel, conforming to ASTM-A183, minimum tensile strength, 758,400 kPa.
- .6 Mechanical couplings for non-threaded pipe are to be certified for use with that pipe, by all agencies certifying the piping systems.
- .7 Flanges with integral grooved neck adapter are approved. Grooved mechanical coupling split flange systems are not approved as reducing fittings.

2.4 Strainers

- .1 Size 51 mm and under: Screwed or grooved, brass, or iron body, Y pattern with 0.8 mm stainless steel perforated screen.
- .2 Size 64 mm to 102 mm: Flanged or grooved iron body, Y pattern with 1.2 mm stainless steel perforated screen.
- .3 Size 127 mm and larger: Flanged or grooved iron body, basket pattern with 3 mm stainless steel perforated screen.
- .4 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

2.5 Solder

- .1 Potable water systems have lead content less than 0.2%.

2.6 Flanges

- .1 Forged steel, 125 pound, slip on or weld neck configuration.

2.7 Overflow Drain Spout

- .1 Cast bronze, lip extension, full face plate and wall flange.
- .2 Equal to Zurn ZAB-199.

3. EXECUTION

3.1 General

- .1 Make connections to equipment and branch mains with unions.
- .2 Provide non-conducting type connections wherever jointing dissimilar metals.
- .3 Do not run combustible or non-approved pipe through fire separations. Use approved materials and methods only.

- .4 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.
- .5 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

3.2 Existing Systems

- .1 Relocate existing services and piping systems to suit new work. Determine the extent of the requirements by inspection of the site and conditions.
- .2 Relocate existing systems and components as required to allow for installation of new or renovated systems.

3.3 Preparation

- .1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembling. Remove welding slag or other foreign material from piping.

3.4 Steel Pipe Connection

- .1 Screw joint steel piping up to and including 38 mm. Screw or weld 51 mm piping. Weld piping 64 mm and larger, including branch connections.
- .2 Make screwed joints with standard NPT configuration. Use approved nontoxic joint compound or teflon tape.
- .3 Use full sized tees or main sized saddle type branch connections for directly connecting branch lines to mains in steel piping. Do not project branch pipes inside the main pipe.
- .4 Make reductions in large water pipes with eccentric reducing fittings installed to provide drainage and venting.

3.5 Hub and Spigot Connections

- .1 Clamp hub and spigot pressure pipe at end of line fittings with 19 mm rods and properly clamped and anchored support.
- .2 In-ground hub and spigot elbows and tees shall be founded with thrust blocks as specified elsewhere. Clamp and rod connections only, are not approved.

3.6 Grooved Mechanical Couplings

- .1 Use grooved mechanical coupling and mechanical fasteners only in accessible locations.
- .2 Use grooved mechanical coupling to engage and lock grooved or shouldered pipe ends. Use flexible grooved fittings where required to allow for some angular deflection, contraction and expansion.
- .3 Contractor to provide proof of completion of installation training by grooved mechanical coupling manufacturer or manufacturer's representative on site prior to start of construction.

3.7 Grades, Routes and Installations

- .1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space.
- .2 Run exposed piping parallel to walls. Group piping wherever practical at common elevations.
- .3 Install concealed pipes close to the building structure to keep furrings to a minimum.
- .4 On closed systems, equip low points with 19 mm drain valves and hose connection.
- .5 At high points, provide collecting chambers and high capacity float operated automatic air vents.

3.8 Priming

- .1 Prime coat exposed pipe, pipe hangers and supports. Pipes, pipe hangers and supports located in crawlspaces, pipe shafts and suspended ceiling spaces are not considered exposed.

1. GENERAL

1.1 Work Included

- .1 Pressure gauges and pressure gauge taps.
- .2 Thermometers and thermometer wells.
- .3 Combination instrumentation taps and gauges.

1.2 Submittals - Prior to Construction

- .1 Submit with shop drawings list which indicates use, operating range, and suitable range of each gauge and thermometer.

1.3 General Requirements

- .1 All meters, gauges and thermometers shall be calibrated in SI (Metric) Units.

2. PRODUCTS

2.1 Pressure Gauges

- .1 Steel case, 90 mm diameter minimum, phosphor bronze bourdon tube brass movement, extruded brass socket.

2.2 Pressure Gauge Taps

- .1 Brass needle valve, ball valve.

2.3 Stem Thermometers

- .1 230 mm long, adjustable scale, red indicator, brass separable socket.
- .2 Well: Brass separable socket complete with gasket and cap, size as required.
- .3 Provide tilt adjustment on devices if required to view without climbing from floor.

2.4 Dial Face Thermometers

- .1 70 mm diameter, white background, black scale indicator, brass separable socket.
- .2 Well: Brass separable socket complete with gasket and cap, size as required.

2.5 Combination Tapping for Instrumentation

- .1 Brass fitting with concentric hole fitted with self-sealing probe, two self closing synthetic rubber gaskets, 6 mm threaded application, threaded brass dust cap with gasket and strap.
- .2 Equal to Petersen 311 Series (Pete's Plug II).

3. EXECUTION

3.1 Pressure Gauges and Taps

- .1 As described on drawings and schedules.
- .2 Install pressure gauges in welded thread-o-lets or mechanical tee fittings. Do not tap piping.
- .3 Provide only one pressure gauge per pump. Install common header, 12 mm diameter pipe, complete with control ball valves to allow selection of pressure reading from each of the following points. Refer to schematic diagram.
 - .1 Before strainers.
 - .2 On pump suction.
 - .3 On pump discharge.

- .4 Provide pressure gauges on new fire sprinkler zone as follows:
 - .1 Upstream of automatic valve
 - .2 Downstream of automatic valve
 - .3 At zone branch take-offs

3.2 Thermometers

- .1 As described on drawings and schedules.
- .2 Install in locations allowing ease of accurate observation without obstruction, light glare or danger to the reading technicians.
- .3 Provide tilt adjustment on devices if required to view without climbing from floor.

3.3 Combination Tapping for Instrumentation

- .1 As described on drawings and schedules.
- .2 On schedule 40 or thicker steel pipe, operating at pressures less than 450 kPa (65 psig), drill and tap the pipe for installation of the combination tap fitting.

1. GENERAL

1.1 Work Included

- .1 Butterfly valves.
- .2 Ball valves.
- .3 Relief valves.
- .4 Check valves.
- .5 Drain valves.
- .6 Hose bibbs.
- .7 Backflow preventers.
- .8 Backflow preventers testing devices.
- .9 Backflow preventers test reports.
- .10 Pressure regulating valves - gas.
- .11 Combination metering and balancing valves.
- .12 Constant flow devices.

1.2 Manufacturer

- .1 Provide valves of same manufacturer throughout where possible.
- .2 Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

1.3 Quality Assurance

- .1 Valves for fire protection systems shall be approved by Factory Mutual & Underwriters Laboratories Canada.
- .2 Valves for gas service shall be trimmed and approved for specified service.

1.4 Submittals – Prior to Construction

- .1 Manufacturers' data and shop drawings for all valves and accessories including dimensions, pressure ratings, materials, service acceptability.
- .2 Manufacturers' data, shop drawings and instructions for backflow preventer testing equipment including dimensions, pressure ratings, materials, service acceptability.

1.5 Submittals – Prior to Substantial Completion

- .1 Backflow preventer test report and certification.

1.6 Acceptable Manufacturers

- .1 Manufacturers of combination metering and balancing valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Tour & Anderson, Wheatley, Bell and Gossett.
- .2 Manufacturers of constant flow devices whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Hayes, Victaulic, Griswold
- .3 Manufacturers of water service ball valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Kitz, Newman Hattersley, Red and White, Toyo.

- .4 Manufacturers of gas service ball valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Newman Hattersley, Red and White, Toyo.
- .5 Manufacturers of spring loaded check valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Centre Line, DeZurik, Hagen, Mission, Mueller, M&G, Singer, Crane, Jenkins, Lunkenheimer.
- .6 Manufacturers of relief valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Consolidated, Crosby Aston, Farris, Kunkle, Lonergan, Singer, Watts, Lunkenheimer, Crane.
- .7 Manufacturers of reduced pressure backflow preventers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Watts, Febco, Combraco.
- .8 Manufacturers of water pressure regulating valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Braukman, Watts, Singer, Febco, Mueller.
- .9 Manufacturers of natural gas pressure regulating valves intended for boiler service whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Pietro Fiorentini, Fisher.
- .10 Manufacturers of butterfly valves whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Crane, Demco, DeZurik, ITT, Grinnell, Jenkins, Keystone, Hattersly.
- .11 Manufacturers of hose bibbs whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Watts, Zurn, Woodford, Mifab.
- .12 Manufacturers of valves for grooved pipe whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Victaulic

2. PRODUCTS

2.1 Valve Connections

- .1 Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.
- .2 Thread pipe sizes 51 mm and smaller.
- .3 Flange pipe sizes 64 mm and larger.
- .4 Solder or screw to solder adaptors for copper piping.
- .5 Use grooved body valves with mechanical grooved jointed piping.
- .6 Provide butterfly valves with tapped lug body when used for isolating service.

2.2 Check Valves – Clear Water, Domestic, Hydronic

- .1 Bronze, swing disc, solder, grooved or screwed ends.
- .2 Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.
- .3 Iron body, bronze trim, spring loaded, renewable composition disc, flanged ends.

2.3 Butterfly Valves

- .1 Bi-directional and dead-end service, ductile iron with blowout proof stainless steel stems and electroless nickel coated ductile iron disc. Seat material shall be EPDM and have a full 360 deg. continuous contact with the seating surface. Disc shall be offset from the centre line.

2.4 Pressure Regulating Valves - Natural Gas – Boiler Service

- .1 Metal body, composition rubber diaphragm, plated or stainless steel spring, internal strainer.
- .2 Internal and external vent limiters, positive dead-end lockup, inlet and outlet test ports, 500 to 1 turndown.
- .3 Acceptable Model: Pietro Fiorentini Governor Over Pressure Device (OPD) Model.

2.5 Relief Valves

- .1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure as indicated.

2.6 Drain Valves

- .1 Bronze compression stop with 19 mm hose threaded.
- .2 Brass ball valve with 19 mm hose thread.
- .3 Provide hose thread connection on valve or piping.

2.7 Hose Bibbs

- .1 Type HB-1: Non-freeze type with wall plate, extended hose thread spout, removable key, integral vacuum breaker. Equal to Woodford model 65
- .2 Type HB-2: Non-freeze type, solid brass operation rod, chrome double-check backflow preventer, chrome hose thread spout, hardened steel operating stem, semi-recessed box, locking drainable cover, equal to Woodford 68.
- .3 Type HB-3: Non-freeze post roof hydrant, cast iron RH-MS roof hydrant mounting kit, aluminum casing guard, extended NHT spout with vacuum breaker, NPT inlet, brass trim, removable handle, drain port in warm space to be piped to exterior. Equal to Woodford RHY2-1-MS.
- .4 All hose bibbs to be provided with approved shut-off valves and vacuum breakers or backflow preventers as required. Note that flush box hose bibb HB-2 will not be approved with a spout mounted vacuum breaker. Provide in-line vacuum breaker in supply line if not included in hose bib assembly.

2.8 Backflow Preventers - Reduced Pressure Type

- .1 Bronze or red brass body, stainless steel springs, composition diaphragm.
- .2 Independent acting spring loaded double internal disc valve, three chamber, discharge to atmosphere.
- .3 Acceptable Models:
 - .1 Watts 009 QT
 - .2 Febco 825 Y
 - .3 Combraco 40-200
- .4 Non-electronic testing apparatus including gauge, hoses, fittings, accessories, and case. Maximum temperature 105 degrees Celsius, maximum pressure 1,050 kPa. Equal to Watts TK-9A.

2.9 Ball Valves

- .1 Up to 64 mm: Forged bronze body, delrin seat and seals, chrome plated ball, forged steel pin, screwed ends, 1200 kPa (175 psig) WOG.

- .2 Tail piece supply isolation valves: ball type valves, angle configuration, screw driver operated, compression fittings or threaded as required, chrome plated if exposed.

2.10 Combination Balancing and Metering Valves

- .1 Brass body, brass plugs and washers, screwed ends, calibrated gauge, lockable.
- .2 Integral ports for sensing flow and connection of meter tubes. Ports complete with integral check valves.

2.11 Constant Flow Device

- .1 Valve shall maintain constant flow independent of pressure differential.
- .2 Maintain design flow rate at a differential pressure of 14 kPa (2 psi).
- .3 Brass body with union coupling on inlet and threaded connection on outlet.
- .4 Valve size to equal the inlet and outlet size of the heat pump, sized for the unit water flow.
- .5 Capacity, flow and pressure drop clearly stamped on body.
- .6 Capacity control cartridge must be replaceable so that design flow rate can be changed without changing the valve body.
- .7 Valves used for domestic water recirculation shall be stainless steel and NSF listed for hot potable water.

2.12 Pressure Ratings

- .1 Unless otherwise indicated, use valves suitable for minimum 862 kPa (125 psig) WSP and 230 degrees C (450 degrees F).
- .2 Use valves for fire protection suitable for 1207 kPa (175 psig) WOG.

2.13 Valve Operators

- .1 Balance Valves any type: provide locking memory stop.
- .2 Provide one plug cock wrench for every plug cock valve.
- .3 Butterfly Valves HVAC service:
 - .1 Less than 200 mm: Provide 10 – position handle with memory stops for shutoff service
- .4 Butterfly Valves Fire Protection: Infinitely adjustable handle with locknut and memory stop, and integral tamper switch.

3. EXECUTION

3.1 Installation and Application

- .1 Install valves with stems upright or horizontal, not inverted, unless otherwise noted.
- .2 Install gate valves with stems horizontal or 45 degrees down from horizontal.
- .3 Use ball valves for gas service. Plug cocks are not to be used for gas isolation service.
- .4 Use only combination balance and metering valves in water systems for throttling service.
- .5 Use butterfly valves in heating water systems.

3.2 Isolation Valves

- .1 Isolation valves are to be ball type valves, pipe size as required, but in no case less than 12 mm diameter.
- .2 For equipment removal purposes, isolation valves are to be installed with companion screwed unions on piping less than 75 mm diameter, or flanged connections on piping 75 mm and larger. Grooved mechanical couplings may be used for equipment removal, subject to accessibility, suitability and where approved by specification terms for that piping system or equipment.

- .3 Install valves as close as possible to isolated equipment in order to minimize the amount of water lost during maintenance, replacement or drain down operations.
- .4 Isolation drain valves are to be provided with combination air inlet fitting as required to relieve vacuum during draining operations.
- .5 Install gate valves or ball valves where approved for shutoff and isolating service, or to isolate equipment, parts of systems or vertical risers.
- .6 Provide drain valves at main shutoff valves, low points of piping and equipment including but not limited to:
 - .1 Pumps
 - .2 Tanks
 - .3 Mixing or other automatic valves
 - .4 Heat exchangers
 - .5 Coils
 - .6 Hydronic heaters
 - .7 Air vents - manual or automatic
 - .8 Washroom groups
 - .9 Hose bibbs
 - .10 Branch lines from mains - plumbing and HVAC
 - .11 All equipment
 - .12 All plumbing fixtures

3.3 Drain Valves

- .1 Provide ball valves for drains on open systems such as evaporative sprays or HVAC storage tanks, or other systems where valves are likely to be plugged by silt or precipitate. This type of valve will allow rodding of the valve in the open position to clear the stoppage.
- .2 Provide unions downstream of the valve to allow breaking the piping system.
- .3 Provide hose thread connection on drain valve and piping.

3.4 Relief Valves

- .1 Test relief valve. Ensure that it reseats correctly without leaking and does not splash or cause flooding at discharge.
- .2 Pipe directly to drain, with discharge facing down into drain. Do not terminate horizontally or in any other configuration where discharge may splash out of drain.

3.5 Hose Bibbs

- .1 All hose bibbs to be provided with approved shut-off valves, inside the building. Provide drain valve on leg if necessary.

3.6 Specialty Valves

- .1 Provide relief valves on boilers, pressure or hot water tanks, or where required. Unless otherwise specified, pipe overflow to drain.
- .2 For glycol based systems pipe relief valve overflow to glycol recovery/storage/makeup tank.
- .3 Provide pressure reducing valves where shown or where required. Provide valved bypass around PRV station, one nominal pipe size smaller than water service. Provide PRV on bypass pipe in parallel with the main PRV. Provide adequately rated shutoff gate valve and bypass globe valve.

3.7 Backflow Preventers

- .1 Provide reduced pressure type backflow preventers where shown or where required as follows: Irrigation system connection, boiler make up, glycol storage tanks, cooling towers, laboratory equipment supplies. Pipe overflow to drain with air gap.

3.8 Combination Balancing and Metering Valve

- .1 Provide combination balancing and metering valves in the following locations:
 - .1 As shown on drawings
 - .2 Boilers
 - .3 Mixing or other automatic valves
 - .4 Coils
 - .5 Hydronic heaters
 - .6 Branch lines from mains
- .2 Valves to be sized for designed flow, regardless of pipe size. Provide reducers from pipe size if required.
- .3 Install in location suitable for installation of meter.
- .4 Balancing valves with memory stop feature, that can be closed tightly, can be used also as isolation valves, subject to all other requirements for clearance, drain ability, position to minimize lost water, etc. and proper position for metering function can be met. If any of these issues, or other critical limitations cannot be met, the balancing valve cannot be used as an isolation valve. A separate dedicated isolation valve must be provided.

3.9 Constant Flow Devices

- .1 Provide constant flow valves in the following locations:
 - .1 As shown on drawings
 - .2 Hydronic heaters
 - .3 Branch lines from mains
- .2 Devices to be sized for designed flow, regardless of pipe size. Provide reducers from pipe size if required.
- .3 Install in location suitable for inspection.
- .4 Install constant flow devices with internal cartridges removed and tie-wrapped to the valve bodies. Do not install cartridges until flushing and cleaning are complete.

3.10 Pressure Regulating Valve - Natural Gas

- .1 Provide pressure reducing valves where shown or where required.
- .2 Provide schedule 40 steel pipe on vent to discharge outdoors or above rooftop unit as required.

1. GENERAL

1.1 Work Included

- .1 Pipe hangers and supports.
- .2 Duct hangers and supports.
- .3 Roof pads.

1.2 Quality Assurance

- .1 Plumbing pipe supports shall meet the requirements of BC Plumbing Code.
- .2 Natural gas pipe supports shall meet the requirements of CGA B 149.1 Installation Code for Natural Gas Fired Appliances.
- .3 Duct hangers shall follow the recommendations of the SMACNA Duct Manuals.
- .4 Sprinkler or Standpipe supports shall meet the requirements of NFPA.
- .5 Hydronic water pipe supports shall meet the requirements of ANSI B31.1, Power Piping.

1.3 Acceptable Manufacturers

- .1 Manufacturers of roof pad supports whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Dura-Blok, Mifab.

2. PRODUCTS

2.1 Pipe Hangers and Supports

- .1 Hangers:
 - .1 Pipe Sizes 13 mm to 38 mm: Adjustable wrought steel ring, or plated strap.
 - .2 Pipe Sizes 51 mm and over: Adjustable wrought steel clevis.
 - .3 Hot Pipe Sizes: 152 mm and Over: Adjustable steel yoke and cast iron roll.
- .2 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 152 mm and over.
- .3 Wall Support:
 - .1 Pipe Sizes to 75 mm: Cast iron hook, or fabricated bracket of 25 mm x 25 mm x 6 mm angle bar.
 - .2 Pipe Sizes 100 mm and Over: Welded steel bracket and wrought steel clamp.
 - .3 Hot Pipe Sizes 150 mm and Over: Adjustable steel yoke and cast iron roll.
- .4 Vertical Support: Steel riser clamp.
- .5 Roof Pads:
 - .1 UV resistant rubber with bolted galvanised steel channel.

2.2 Hanger Rods

- .1 Provide steel hanger rods, threaded both ends, or continuous threaded, complete with lock nuts on both ends.

2.3 Duct Hangers and Supports

- .1 Hangers:
 - .1 Concealed - Round Duct: Galvanized steel band iron.
 - .2 Concealed - Rectangular Duct: Galvanized steel band iron or rolled angle and 9 mm rods.
 - .3 Exposed - Round Duct: Continuous galvanized steel band iron secured to single 9 mm hanger rod.
- .2 Wall Supports: Galvanized steel band iron or fabricated angle brackets.
- .3 Vertical Support at Floor: Rolled angle.

2.4 Inserts

- .1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.
- .2 Size inserts to suit threaded hanger rods.

3. EXECUTION

3.1 General Requirements

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction.
- .2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.
- .3 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.
- .4 Do not cut, drill or weld to structural elements without prior approval from the department representative.
- .5 Perforated metal strapping is not an acceptable means of supporting piping, ducting or mechanical equipment.

3.2 Pipe Hangers and Support

- .1 Fasten hangers and supports to building structure or inserts in concrete construction.
- .2 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports	Hanger Rod Diameter
.1 0 mm to 13 mm	2m	10 mm
.2 19 mm to 38 mm	2m	10 mm
.3 51 mm to 64 mm	3m	10 mm
.4 76 mm to 102 mm	3m	13 mm
- .3 Install hangers to provide minimum 15 mm clear space between finished covering and adjacent work.
- .4 Place a hanger within 300 mm of each horizontal elbow.
- .5 Use hangers which are vertically adjustable 40 mm minimum after piping is erected.
- .6 Support vertical piping at every floor. Support vertical soil pipe at each joint.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Where practical, support riser piping independently of connected horizontal piping.

- .9 Support horizontal soil pipe near each joint, with 1,500 mm maximum spacing between hangers.
- .10 Provide copper plated hangers and supports for copper piping or provide nonferrous packing between hanger or support and piping.
- .11 Large capacity piping with vibration potential shall not be suspended from any building structure that will allow transfer of vibrations to the occupied spaces.
- .12 Pipe Hanger and Supports - Fire Protection; Comply with NFPA requirements. Refer to Specification 21, Fire Protection System.

3.3 Low Pressure Duct Hangers and Supports

- .1 Hanger minimum sizes:
 - .1 Up to 760 mm wide or 460 mm diameter: 15 mm x 16 gauge at 3.0 m spacing.
 - .2 760 mm to 1,200 mm wide, or over 460 mm diameter: 38 mm x 16 gauge at 3.0 m spacing.
 - .3 Over 1,200 mm wide: 38 mm x 16 gauge at 3.4 m spacing.
- .2 Horizontal duct on wall supports minimum sizes:
 - .1 Up to 460 mm wide: 38 mm x 16 gauge or 25 mm x 25 mm x 3 mm at 2.5 m spacing.
 - .2 460 mm to 1,000 mm wide: 38 mm x 38 mm x 2 mm at 1.5 m spacing.
- .3 Vertical duct on wall supports minimum sizes:
 - .1 Riveted or screwed to duct:
 - .2 Up to 1,520 mm wide: 38 mm x 38 mm x 3 mm.
 - .3 Over 1,520 mm wide: 51 mm x 3 mm.
- .4 Vertical duct floor supports minimum sizes:
 - .1 Riveted or screwed to duct:
 - .2 Up to 1,500 mm wide: 38 mm x 38 mm x 3 mm.
 - .3 Over 1,500 mm wide: 51 mm x 51 mm x 3 mm.

3.4 Priming and Coating

- .1 Prime coat exposed steel hangers and supports. Hangers and supports located in crawlspaces, pipe shafts and suspended ceiling spaces are not considered exposed.

3.5 Equipment Bases and Supports

- .1 Concrete housekeeping pads are specified under other divisions of the specification. Bases shall be 100 mm thick minimum, extended 100 mm minimum beyond machinery bedplates. This Division will provide templates anchor bolts and accessories required for mounting and anchoring equipment.
- .2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .3 Provide rigid anchors for ducts and pipes immediately after vibration connections to equipment.
- .4 Suspend mechanical equipment from structure with adjustable length steel rods. Provide spreader beams to distribute weight.

3.6 Inserts

- .1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 102 mm or ducts over 1,500 mm wide.

- .3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.
- .5 Expansion bolt type connections will be approved under certain conditions. Obtain approval from the Department representative. Generally pipe 51 mm or smaller, and duct less than 600 mm x 300 mm will be approved, subject to adequate number of support points.

3.7 Exposed Duct Support

- .1 Supply and return ducts exposed in the finished areas are to be supported by continuous strap installed around the duct. Only one joint on the strap is approved, at the top to secure the strap ends together and to connect to a threaded rod.
- .2 The threaded rod shall be secured to trusses or to steel angle bars spanning the trusses. The steel spanning bars are to be provided by this division.
- .3 Supports for equipment suspended within the space frame, are to be connected to the bolted node joints of the space frames. The locations of duct and piping suspension connections to the node joints must be coordinated and installed before the space frames are assembled and lifted to position. Refer to detail.
- .4 Supports for equipment supported above the space frame, may be connected to the bolted node joints of the space frames, or from the fluted steel deck above. The locations of duct and piping suspension connections to the node joints must be coordinated and installed before the space frames are assembled and lifted to position. Refer to detail.

1. GENERAL

1.1 Work Included

- .1 Flashing for mechanical equipment.
- .2 Sleeving for mechanical equipment.
- .3 Fire stop seals.

1.2 Quality Assurance - Firestop Sealants

- .1 Standard method of fire tests : CAN4-S115-M85, ASTM E814, UL1479, UL 2079.
- .2 Materials shall be listed by FM and certified by UL or ULC for the service application.

1.3 Quality Assurance - Firestop Collars

- .1 Standard method of fire tests : CAN4-S115-M85, ASTM E814, UL1479, UL 2079.
- .2 Seals, assemblies and materials for penetration of fire rated surfaces shall be listed by FM and certified by UL or ULC for the service application.

1.4 Submittals – Prior to Construction

- .1 Firestop materials: Submit service limitations, installation instructions, UL certification and FM listing.
- .2 Fire rated penetration seals: Submit dimensional data, service limitations, installation instructions, UL certification and FM listing.

1.5 Acceptable Manufacturers

- .1 Manufacturers of fire stopping materials whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Self Seal, Hilti, 3M.

2. PRODUCTS

2.1 Sleeves - Duct

- .1 Round Ducts: Form with galvanized steel.
- .2 Rectangular Ducts: Form with galvanized steel.

2.2 Sleeves - Pipe

- .1 Domestic water, gas, hydronic, chilled, glycol, fire protection, drainage, etc.: Pipes through beams, wall, fire proofing, footings, floor: Form with steel pipe, schedule 20, galvanized.
- .2 Underground sleeve for gas pipe: PVC or other approved non-metallic material, minimum diameter 25 mm greater than outside diameter of gas pipe.

2.3 Flashing

- .1 Steel Flashing: 26 gauge galvanized steel.
- .2 Aluminum flashing: 26 gauge sheet aluminum.

2.4 Firestop Sealant

- .1 Tested and rated for mechanical fire protection for protection of penetrations utilizing PVC or CPVC pipe, PVC conduit, polyethylene conduit or pipe, other non-metallic pipes, cables, and combustible pipe insulations as the penetrant.
- .2 Single component, low modulus flexible sealant to form pressure tight seal resistant to water, smoke and toxic gases, resistant to cracking, degradation by ultraviolet radiation and ozone.

- .3 Compatible with construction materials of galvanized steel, aluminum, concrete, gypsum board.
- .4 Contain no water soluble expansion ingredients.
- .5 Wall and floor openings: equal to Self Seal GG-200.
- .6 Floor openings: equal to Self Seal SL-100.

2.5 Firestop Collars

- .1 Tested and approved for protection of penetrations utilizing PVC or CPVC pipe, PVC conduit, polyethylene conduit or pipe, other non-metallic pipes, cables, and combustible pipe insulations as the penetrant.
- .2 Intumescent insert: Flexible, elastomeric strip, two stage expansion, designed to firestop penetrations in fire-rated walls and floors and floor/ceiling assemblies.
- .3 Provide a minimum of 15 time free expansion.
- .4 Contain no water soluble expansion ingredients.

3. EXECUTION

3.1 Sleeves

- .1 Provide and set sleeves required for equipment, including openings required for placing equipment.
- .2 Set sleeves in position in advance of other work. Provide suitable reinforcing around sleeves.
- .3 Extend sleeves through potentially wet floors 50 mm above finished floor level. Caulk sleeves full depth and provide floor plate.
- .4 Where ductwork passes through floor, ceiling or wall, close off space between duct and sleeve with non-combustible insulation. Provide tight fitting metal caps on both sides.
- .5 Where piping passes through floor, ceiling or wall, close off space between pipe and sleeve with non-combustible insulation or approved non-combustible insulation, fire rated as required to match the rating of the penetrated surface. Provide tight fitting metal caps on both sides.
- .6 Install chrome plated escutcheons where piping passes through finished surfaces.
- .7 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

3.2 Flashing

- .1 Where mechanical equipment passes through weather or waterproofed walls and roofs, counter flashing shall be provided under this Division. Roof flashing is specified under other divisions of this specification.
- .2 Curbs for mechanical roof installations are specified under other divisions of this specification. Curbs must be minimum 200 mm higher than the top of the finished roof, unless noted otherwise.

3.3 Firestop Sealant

- .1 Apply in conjunction with manufacturer's instructions and all related codes.
- .2 Clean all concrete, masonry and stone penetrations of all contaminants and impurities, concrete form release agents, water repellents, oils, surface dirt and rust, scale, all old sealants and other surface treatments.
- .3 Metal surfaces shall be cleaned by wiping them with an oil-free absorbent cloth saturated with solvent such as xylol or toluol. Do not use alcohols.
- .4 Pack voids with approved, non-combustible void filling material, recessed the appropriate dimension and fill the cavity with approved sealant. Prime mating surfaces if necessary.

- .5 Installation only when temperatures are between 5 degrees Celsius and 35 degrees Celsius.

3.4 Firestop Collars

- .1 Apply in conjunction with manufacturer's instructions and all related codes.
- .2 Clean all concrete, masonry and stone penetrations of all contaminants and impurities, concrete form release agents, water repellents, oils, surface dirt and rust, scale, all old sealants and other surface treatments.
- .3 Metal surfaces shall be cleaned by wiping them with an oil-free absorbent cloth saturated with solvent such as xylol or toluol. Do not use alcohols.
- .4 Do not apply to polycarbonates or to building materials that bleed oils, plasticizers or solvents, or where sealant is not exposed to atmospheric moisture, or to surfaces which have been or will be painted.
- .5 Collars are to be installed with steel fasteners or steel expansion anchors. Low melting temperature anchors of lead, plastic or aluminum are not approved.
- .6 Installation only when temperatures are between 5 degrees Celsius and 35 degrees Celsius.

1. GENERAL

1.1 Work Included

- .1 Seismic restraints for suspended piping systems.
- .2 Seismic restraints for floor mounted equipment and tanks.
- .3 Certification by a Professional Department representative.

1.2 General Requirements

- .1 All seismic restraining devices shall be supplied by an approved supplier with the exception of seismic restraining devices which are factory installed and are standard equipment with the machinery.
- .2 All submittals shall bear the seal and signature of a registered Professional Department representative.

1.3 Standards

- .1 Seismic restraint devices, accessories and methods shall meet the requirements of the British Columbia Building Code.

1.4 Submittals - Prior to Construction

- .1 Letters of Assurance: Submit Supporting Registered Professional Schedule S-B covering the mechanical systems, within the scope of this project, in their entirety. Schedules shall not be qualified or include any notes that would reduce the scope or responsibility.

1.5 Submittals - Prior to Substantial Performance

- .1 Letters of Assurance: Submit Supporting Registered Professional Schedule S-C covering the mechanical systems, within the scope of this project, in their entirety. Schedules shall not be qualified or include any notes that would reduce the scope or responsibility.

1.6 Inspection and Certification

- .1 Mechanical systems Seismic Specialty Engineer: Include for and pay the necessary fees for the services of a qualified Professional Department representative, registered in the province of British Columbia, to provide the necessary certifications required by the British Columbia Building Code, all local codes, and as herein specified.

2. PRODUCTS

2.1 Seismic Restraints

- .1 The restraints shall conform to the requirements of the mechanical systems Seismic Specialty Engineer.

3. EXECUTION

3.1 Application

- .1 It is the responsibility of the contractor to ensure that device sizing and application is correct for each individual system or piece of equipment.
- .2 Provide restraints on all new piping, tanks and equipment that are provided under the scope of the mechanical contract.

3.2 Inspection and Certification

- .1 The Seismic Specialty Engineer shall inspect all components of the completed seismic restraints installation.

- .2 Submit a sealed inspection report declaring that the completed seismic installation is installed in accordance with the plans and specifications prepared by the Seismic Specialty Engineer.
- .3 Letters of Assurance: Submit Supporting Registered Professional Schedules S-B and S-C covering the mechanical systems in their entirety. Schedules shall not be qualified or include any notes that would reduce the scope or responsibility.

SECTION 23 05 93.1 – TESTING

1. GENERAL

1.1 Work Included

- .1 Test and report of existing and new heating, air conditioning and ventilation systems specified, renovated or modified under Division 23.
- .2 Test and report of existing and new plumbing systems specified, renovated or modified under Division 22.
- .3 Test and report of existing and new backflow preventers specified, renovated or modified under Division 21, 22, 23.
- .4 Test and report of existing and new fire sprinkler systems - inside building, specified, renovated or modified under Division 21

1.2 Quality Assurance

- .1 Test equipment and material where specified required by authority having jurisdiction to demonstrate its proper and safe operation.
- .2 Test procedures shall be in accordance with applicable portions of:
 - .1 CSA B149.1 Natural Gas and Propane Installation Code.
 - .2 BC Municipal Affairs Departmental Representative Services Division
 - .3 BC Plumbing Code
 - .4 National Fire Protection Association
 - .5 American Society of Heating, Refrigeration and Air Conditioning Department representatives
 - .6 Sheet Metal and Air Conditioning National Association
 - .7 American Society of Mechanical Department representatives
 - .8 BC Ministry of Health
 - .9 Local codes and ordinances
 - .10 Other recognized test codes
- .3 Provide two days notice to the Departmental Representative before tests.

1.3 Submittals – Prior to Construction

- .1 Qualifications of technicians installing, testing and reporting test results on back flow preventer.

1.4 Submittals – Prior to Substantial Performance

- .1 Obtain certificates of approval and acceptance from authorities having jurisdiction and include in Operating and Maintenance Manuals.
- .2 On completion of mechanical installation, provide certification of tests with detailed data as required. Itemize tests as to time performed and personnel responsible. Include a copy of field data in Operating and Maintenance Manuals.

1.5 Liability

- .1 During tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration.

2. PRODUCTS - Not Applicable.

3. EXECUTION

3.1 Pressure Tests

- .1 Piping, fixtures or equipment shall not be concealed or covered until inspected and reviewed by the Department representative.
- .2 Provide equipment, materials and labour for tests. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers just prior to tests to avoid changes in calibration.
- .3 Carry out pressure and hydraulic tests for 8 hours and maintain pressure. Where leakage occurs, repair and retest.
- .4 Domestic Water Piping: Test to 1-1/2 times maximum working pressure or 1,035 kPa (150 psi) water pressure measured at system low point.
- .5 Drainage Systems: Test by filling with water to produce water pressure of 30 kPa (3,000 mm) minimum and 75 kPa (8,000 mm) maximum. Check for proper grade and obstruction by ball test, or other approved means.
- .6 Natural Gas Piping: Test as required by authority having jurisdiction.
- .7 Low Pressure Ducts: Test for tightness such that leakage is inaudible and not detectable by feel.
- .8 Fire Sprinkler System Piping: shall be tested to 1,380 kPa (200 psi) for two hours.
- .9 Heating Water Piping: Test to 1-1/2 times maximum working pressure or 1,035 kPa (150 psig), whichever is greater.
- .10 During heating and cooling piping system tests, check linear expansion at elbows, U-bends, expansion joints and offsets for proper clearance.
- .11 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and re-welding welded joints, remaking joints in copper lines. Do not caulk.

3.2 Performance Tests

- .1 Refer to Section 23 05 93.3, Commissioning, and assist the Commissioning Agent.
- .2 Provide fresh filters for all air handling equipment prior to testing or balancing.
- .3 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required as tests may indicate prior to operating tests.
- .4 Use or modify manufacturers' reports. Test and adjust equipment and systems as specified, and as required by the manufacturer. Ensure that manufacturers' start up reports are complete and acceptable.
- .5 Provide detailed listing of equipment set up parameters "as left".
- .6 Make operating tests for minimum of five days during heating season of first year of operation and at times when directed, for proper setting of controls under peak load conditions.
- .7 Conduct final operating tests in presence of the Departmental Representative. Vary loads to illustrate start-up and shutdown sequence, and simulate emergency conditions for safety shutdowns, with automatic and manual reset. Make final adjustments to suit exact building conditions.
- .8 Provide labour, ladders, tools and associated equipment required to assist in all tests.

3.3 Back Flow Preventer

- .1 Refer to Section 15100 Valves.

- .2 Conduct commissioning operations and tests to confirm the backflow preventers are properly installed. Reports are to be submitted on forms approved by the local Authority Having Jurisdiction.

3.4 Fire Sprinkler System

- .1 Wet Systems: A test pipe of not less than 5 mm diameter terminating in a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler shall be provided for each system.
- .2 Where flow switches, water flow alarm devices or other zone flow detectors, are provided, or where more than one alarm device is provided in one sprinkler system, a test pipe shall be provided for testing each alarm device.
- .3 Sprinkler system discharge tests shall be conducted using system test modules described. Pressure gauges shall be installed at critical points and readings taken under various modes of auxiliary equipment operation. Water flow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.
- .4 Contractor's Material and Test Certificate: Additional information shall be appended to the Contractor's Material and Test Certificate described in NFPA No. 13.
 - .1 Certification that all auxiliary devices have a pressure rating of 1,210 kPa (175 psi).
 - .2 Water flow tests have been conducted and water flow alarms have operated while auxiliary equipment is in each of the possible modes of operation.
 - .3 With auxiliary equipment tested in each possible mode of operation and with no flow from sprinklers or test connection, water flow alarm signals did not operate.

1. GENERAL

1.1 Work Included

- .1 Balancing and adjustment of all new, renovated or necessary existing systems specified under Division 15 and submit reports.
- .2 Balance, adjust and test HVAC air systems and equipment and submit reports.
- .3 Balance, adjust and test HVAC water systems and equipment and submit reports.
- .4 Balance, adjust and test domestic water circulating systems and equipment and submit reports.
- .5 Fire damper drop test report.
- .6 Assisting in the commissioning of all new, renovated or necessary existing systems specified under Divisions 21, 22, 23 and 25.

1.2 Balance Reports

- .1 Submit draft copies for approval prior to proceeding. Sample balancing report forms for some equipment are available from the Departmental Representative to indicate a minimum expected level of testing. Written approval of draft copies must be obtained before balancing begins.
- .2 Balancing information for each system should be organized and presented in a manner that groups all relevant information about that system in a continuous and contiguous manner.
- .3 Provide reports suitable for inclusion in Maintenance Manuals. Reports not considered acceptable to the Departmental Representative will be revised to a standard and format acceptable to the Department representative.
- .4 Provide initial or interim balancing reports for review by the Department representative. The contractor will contact the Departmental Representative to arrange a meeting for further adjustment of the systems. A minimum of one initial report and meeting will occur, with further reports and meetings as deemed necessary by the Department representative.
- .5 Balance reports to include 'as found' values along with final values.

1.3 System Data

- .1 Reports shall include balance and equipment data listed in S.I. (Metric) units.
- .2 Report data shall include system description, manufacturer, model, serial number, arrangements, motor size, electrical characteristics, equipment size, design and actual temperature, flows, RPM, power, amperage, pressure (air and water, static and velocity), water temperature, room temperature and humidity, outdoor temperature and humidity, etc.
- .3 Provide calibration reports for all instrumentation used, including range and minimum accuracy.
- .4 Provide an as-found system schematic noting the approximate locations of all equipment tested, measured or balanced. Cross reference all diffusers, grilles, terminal equipment etc. with the reported data.
- .5 Indicate all ductwork traverse points on the system schematic.

1.4 Acceptable Balancing Agencies

- .1 Testing and balancing agencies who are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 KD Engineering Ltd., Vancouver
 - .2 Vesta Dynamics, Kelowna.
 - .3 Inland Technical Services Ltd., Kelowna.
 - .4 West Rockies Services, Abbotsford

1.5 Commissioning and Documentation

- .1 Refer to Section 23 05 93.3 Commissioning.
- .2 Refer to Section 23 01 00 Documentation, Manuals and Record Drawings.
- .3 Provide all necessary coordination services between the documentation-balancing operations and the commissioning operations.
- .4 Work with the Commissioning Agent throughout the project to provide necessary tests, adjustments, reports, certifications to complete the project.

2. PRODUCTS

2.1 Maintenance Manual Materials

- .1 Provide copies to the Commissioning Agent, of all shop drawings, reports and forms, materials, etc., required to complete the documentation. This generally includes but is not limited to the following:
 - .1 HVAC air system balance reports.
 - .2 HVAC air equipment test reports.
 - .3 HVAC water system balance reports.
 - .4 HVAC water equipment test reports.
 - .5 Domestic water system balance reports.
 - .6 Boiler balance reports.
 - .7 Pump test reports.
 - .8 Test reports for all equipment provided or installed under Division 15.

2.2 Pump Test Reports

- .1 Report designed and adjusted water flow, water pressure at inlet and discharge, water temperature, pump speed, manufacturer, model, serial number, impeller size, and block tight pressure based on pump curve.
- .2 Test, adjust and report actual water flow, water pressure at inlet and discharge, block tight pressure, water temperature, pump speed, manufacturer, model, serial number, and impeller size.
- .3 For pumps with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted pump performance curve.
- .4 Report the motor manufacturer, model, serial number, horsepower, current, voltage.

2.3 Fan Test Reports

- .1 Report designed and adjusted air flow, air pressure at inlet and discharge, air pressure differential between inlet and outlet, external static pressure, air temperature, initial and final fan speeds, manufacturer, model, serial number, fan wheel size, sheave sizes and position, belt size and quantities,.
- .2 Test, adjust and report air flow, air pressure at inlet and discharge, air pressure differential between inlet and outlet, external static pressure, air temperature, initial and final fan speeds, manufacturer, model, serial number, fan wheel size, sheave sizes and position, belt size and quantities,.
- .3 For fans with power greater than 250 watts, plot design and actual pressure and flow on manufacturer's or drafted fan performance curve.
- .4 Report the motor manufacturer, model, serial number, horsepower, current, voltage, speed.

2.4 Heat Recovery Unit Test Reports

- .1 Follow and submit manufacturer's testing and reporting methods.
- .2 Perform specified testing on both Outdoor Air Supply and Exhaust sections of unit.
- .3 Report designed and adjusted air flow, air pressure at inlet, across filters, and discharge, air pressure differential between inlet and outlet, external static pressure, air temperature at inlet and outlet during operation, initial and final fan speeds, manufacturer, model, serial number, fan wheel size.
- .4 Test, adjust and report air flow, air pressure at inlet, across filters, and discharge, air pressure differential between inlet and outlet, external static pressure, air temperature at inlet and outlet operation, initial and final fan speeds, manufacturer, model, serial number, fan wheel size.
- .5 For each motor, report the manufacturer, model, serial number, horsepower, current, voltage, speed.

2.5 Heating Coil Test Reports

- .1 Report designed and adjusted water flow, water pressure at inlet and discharge, water temperature at inlet and discharge, heat transfer capacity, manufacturer, model, size.
- .2 Report designed and adjusted air flow, air pressure at inlet and discharge, air temperature at inlet and discharge, heat transfer capacity.
- .3 Test, adjust and report actual water flow, water pressure at inlet and discharge, water temperature at inlet and discharge, calculated heat transfer, manufacturer, model, size.
- .4 Test, adjust and report actual air flow, air pressure at inlet and discharge, air temperature at inlet and discharge, calculated heat transfer.

2.6 Air Source Heat Pump Test Reports

- .1 Follow and submit manufacturer's testing and reporting methods.
- .2 Report manufacturer, model, size.
- .3 For both heating and cooling operations, report heat transfer capacity.

2.7 Boiler Test Reports

- .1 Follow and submit manufacturer's testing and reporting methods.
- .2 Report designed and adjusted water flow, water pressure at inlet and discharge, water temperature at inlet and discharge, heat transfer capacity, manufacturer, model, size.
- .3 Test, adjust and report actual water flow, water pressure at inlet and discharge, water temperature at inlet and discharge, calculated heat transfer, flue gas temperature and combustion test, manufacturer, model, size.

2.8 Fan Coil Unit Test Reports

- .1 Report designed and adjusted air flow, air pressure at inlet, across filters, and discharge, air temperature at inlet and outlet during heating and cooling operation, air temperature in inlet, heating capacity, cooling capacity, initial and final fan speeds, manufacturer, model, serial number, fan wheel size.
- .2 Test, adjust and report air flow, air pressure at inlet, across filters, and discharge, air temperature at inlet and outlet during heating and cooling operation, heating capacity, cooling capacity, initial and final fan speeds, manufacturer, model, serial number fan wheel size.
- .3 Report the fan motor manufacturer, model, serial number, horsepower, current, voltage, speed.

2.9 Air Outlets and Inlets

- .1 The word "outlet" shall also mean "inlet" where appropriate.

- .2 Report initial, designed and adjusted air flows, air velocity, outlet size, flow factor (Ak), method used to obtain Ak factor, and supply air temperature.
- .3 Test, adjust and report initial, design and adjusted air flow, air velocity, outlet size, flow factor (Ak), method used to obtain Ak factor, and supply air temperature.

2.10 Fire Damper Drop Test Report

- .1 Report the functioning of each fire damper.
- .2 The report shall list all fire dampers and indicate whether or not they close freely.

2.11 Outdoor Air Adjustment and Report

- .1 Outdoor air values for specific zones, are shown on the drawings.
- .2 Report designed and adjusted return and outdoor air flow at point of mixing.

2.12 Building Pressurization

- .1 Report final building pressurization, including, but not limited to the following:
 - .1 All supply outlets quantities and total.
 - .2 All return inlets quantities and total.
 - .3 All outdoor air quantities and total.
 - .4 All relief exhaust quantities and total.
 - .5 All exhaust fan quantities and total.
 - .6 All other air supplies and exhausts, along with the corresponding totals.
 - .7 Final building pressure.
 - .8 Outdoor air pressure at each building entrance at the time of final balancing, including date and time pressures recorded.

3. EXECUTION

3.1 General Procedure

- .1 Ensure clean filters are installed prior to balancing.
- .2 Balance to maximum measured flow deviation from specified values of 10% at terminal device and 5% at equipment.
- .3 If design air or water flow rates cannot be achieved, investigate the cause and report to the department representative. Review motor sizes, motor rotation, balancing damper and valve dispositions, static pressures, dead-head pressures, system effects and any other elements required to ascertain the cause of the shortfall. Report the maximum water or air flow that can be achieved with the current configuration. Provide any additional site visits that may be required to complete the investigation.
- .4 Mark settings on valves, dampers and other adjustment devices.
- .5 Take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .6 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Department representative.
- .7 Balancing to include 'as found' values along with final values.
- .8 Report duct dimensions and air velocities when using a pitot traverse to determine airflow in a duct.

3.2 Air System Procedure

- .1 Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities.
- .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.
- .3 Measure air quantities at air inlet and outlet.
- .4 Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices, such as dampers and splitters.
- .5 Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- .6 Provide system schematic with required and actual air quantities at each outlet or inlet.
- .7 Provide and adjust belts and sheaves as required to meet required air flows.

3.3 Water System Procedure - Heating or Cooling Systems

- .1 Adjust water systems to provide required or design quantities.
- .2 Use calibrated venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flow through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shutoff valves for balancing unless indexed for balance point.
- .6 Where pump capacity available is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
- .7 Where Constant Flow Devices are installed, confirm that the device flow rates match the required equipment flow rates, and confirm that the total pressure drop across the devices are sufficient to provide the desired flow. Include results in the test reports.

3.4 Water System Procedure - Domestic Water System

- .1 Adjust recirculating water systems to provide constant flow conditions.
- .2 Adjust tempered water control and recirculating systems to provide constant temperature conditions under all flow conditions.
- .3 Measure temperatures at control devices and at fixtures outlets.
- .4 Submit written report.

3.5 Fire Damper Drop Test Report

- .1 The sheet metal trade shall remove the fusible links and demonstrate that damper can close freely and without obstruction.
- .2 Report obstructed or non-functioning dampers to the mechanical trade. Perform test again once repairs have been completed and as required.

3.6 Outdoor Air Adjustment

- .1 Outdoor air values for specific zones are shown on the drawings. On systems with the specified outdoor air component, the return air duct is sized for 100 % return air flow to accommodate the specified air flow during unoccupied mode. The air flow value identified on drawings for such return air grilles is the value for 100 % return. During occupied mode, the return air flow will not be at this identified value, but will be the difference between supply air flow, less the outdoor air component.
- .2 Manual dampers are to be adjusted to provide the specified outdoor air component during occupied mode. The adjustment is to be determined by comparing the mixed air temperature, return air temperature, and outdoor air temperature. During periods when the temperature difference between outdoor and return air is less than 10 degrees Celsius, the Departmental Representative may approve an alternate method of measurement by air flow through tight fitting, well calibrated, air flow measuring hoods.
- .3 Report the designed and adjusted supply, return and outdoor air flow at point of mixing, and include temperatures recorded during the test and adjustment process.

1. GENERAL

1.1 Work Included

- .1 Commissioning and final adjustment of all systems provided or installed under Divisions 21 22 23 25 under supervision from the Commissioning Authority.
- .2 Cooperate with the Commissioning Authority.
- .3 Verification of building automation system sequences, schedules, and normal operation.
- .4 Verification of correct normal and emergency operations for all systems provided or installed under Division 21 22 23 25.
- .5 Verification of balancing reports.
- .6 Direction to the contractors for minor system revisions during the construction process.
- .7 Direction to the contractors for system adjustment for all systems provided or installed under Division 15.
- .8 Coordination of system testing and balancing with other systems requiring set-up by manufacturers.
- .9 Coordination of contractor and manufacturer presented training sessions for all systems and equipment provided or installed by Division 15.
- .10 Participation in the handover of systems to the Departmental Representative.
- .11 Development of a scheduled, planned and certified handover process of systems to the Departmental Representative.
- .12 Training and instructions to Departmental Representative of all systems provided or installed under Division 15.

1.2 System Data

- .1 Reports shall include balance and equipment data listed in S.I. (Metric) units.
- .2 Report data shall include system description, manufacturer, arrangements, motor size, electrical characteristics, equipment size, design and actual temperature, flows, RPM, power, amperage, a pressure (air and water, static and velocity), water temperature, room temperature and humidity, outdoor temperature and humidity, etc.
- .3 Review requirements with the Balancing contractor.

1.3 Submittals

- .1 Balance reports: Refer to Section 23 05 93.1, Testing 20 05 93.2 Balancing.
- .2 Equipment start up reports: refer to requirements specified in other Sections of this specification.
- .3 Provide receipts from Departmental Representative for components, spare parts, testing equipment, etc., as specified in this section.

1.4 Quality Assurance

- .1 Commissioning of mechanical systems shall be performed by an agency that specializes in this type of work.
- .2 Technicians performing the work shall be experienced in projects of similar scale and nature.

1.5 Acceptable Agencies

- .1 Commissioning agencies who are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 KD Engineering Ltd., Vancouver

- .2 Vesta Dynamics, Kelowna.
- .3 Inland Technical Services Ltd., Kelowna.
- .4 West Rockies Services, Abbotsford

2. PRODUCTS

2.1 Operation and Maintenance Manuals Materials

- .1 Ensure copies of all shop drawings, reports and forms, materials, etc., required to complete the documentation are provided.
- .2 Prepare proper documentation to instruct the building operator in the operation and preventative maintenance of equipment and systems provided. Complete and turn over documentation prior to Substantial Performance inspection.
- .3 Refer to Section 23 01 00 Documentation, Manuals and Record Drawings.

2.2 Balance Reports

- .1 Coordinate submission of draft copies of reports.
- .2 Ensure specified number of final copies for inclusion in Operating and Maintenance Manuals are provided.
- .3 Verify reports specified under Section 23 05 93.1 Testing, Adjusting and Balancing.

2.3 Equipment Test Reports

- .1 Use or modify reports specified under Section 23 05 93.1 Testing and 23 05 93.2 Balancing.
- .2 Use or modify manufacturers' reports. Test and adjust equipment and systems as specified, and as required by the manufacturer. Ensure that manufacturers' start up reports are complete and acceptable.
- .3 Provide detailed listing of equipment set up parameters "as left"

2.4 Commissioning Services - General

- .1 Prior to start of the commissioning process, the contractor shall submit to the Commissioning Authority, the following:
 - .1 Proposed commissioning schedule and procedures.
 - .2 Forms and checklists showing the entire list of actual systems and equipment, including all operations and set points that will be checked and reported.
 - .3 Personnel and equipment that will be used.
- .2 Pre-commissioning Meeting: The Commissioning Agent shall organize a meeting with the Commissioning Authority, Department representative, heating sub-contractor, plumbing sub-contractor, controls sub-contractor, major equipment suppliers (boilers, air source heat pumps automatic sprinklers) prior to the start of Phase One Commissioning. The meeting will establish and clarify the requirements and schedule of each member of the construction team, and the method and format of certification and test reports.
- .3 Descriptive Data: Review design concepts and general function of each system including associated equipment and operation cycles. Confirm listing of flow and terminal measurements to be performed.
- .4 Procedure Data: Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application and correct factors.

3. EXECUTION

3.1 Construction Period Services

- .1 The Commissioning Agent will attend at the site during the construction period. Cooperate with the Commissioning Authority and undertake the required modifications and renovations as instructed. The number of site visits shall be as required, and shall be coordinated with the construction process to provide the following:
 - .1 Attend and organize commissioning meetings as outlined by the Commissioning Authority.
 - .2 Comment to the Departmental Representative with respect to system configuration and provide recommendations for changes that should be considered in order to achieve the specified system performance.
 - .3 Comment to the Division 21 22 23 & 25 contractors with respect to system configuration and the effect that the construction conditions will have on system performance.
 - .4 Instruct the Division 21 22 23 & 25 contractors with respect to configuration changes required to achieve the specified system performance.
 - .5 Review all specified water flows and compare required flow to balancing and metering valve, or automatic valve selection.
 - .6 Provide written report on recommendations.

3.2 Commissioning Phase One - Pre-Commissioning

- .1 Prior to commencing commissioning tasks on any system, confirm or provide the following:
 - .1 Certification that the subject systems are ready for the commissioning process.
 - .2 Permanent electrical connections are complete and accepted by the Electrical Department representative.
 - .3 All safety controls are complete and operational.
 - .4 All operating controls are complete and activated.
 - .5 Flushing and cleaning of piping systems related to the subject systems have been completed.
 - .6 Ductwork related to the subject systems are cleaned, and satisfactory filters are installed.
 - .7 Refrigeration systems related to the subject systems are fully charged and commissioned.
 - .8 Related vibration isolation components are properly adjusted.
 - .9 Schedule of all electric motors provided under this division, identifying manufacturer, model number, power rating, frame size, voltage, speed, and efficiency.
 - .10 Fire sprinkler systems are complete and activated.
 - .11 All permits are in hands of the contractor.
- .2 Provide written reports on all necessary systems. Do not proceed to the next phase, without written acceptance of this phase, by the Department representative.

3.3 Commissioning Phase Two - Commissioning Operations

- .1 As each system is started and tested, and balancing and adjusting is underway or completed, the overall performance of the components and systems, including the controls, shall be tested, properly adjusted, verified under all operating conditions and reported.

- .2 Commissioning tasks shall include but not be limited to the following:
 - .1 In the accompany of equipment suppliers and the Division 21, 22, 23, and 25 contractors, each piece of equipment provided by these Divisions shall be started and checked for correct operation and for correct interlocking and parallel operation with other equipment and systems.
 - .2 Activation of all components, systems and sub-systems, both manually and through the automatic control systems.
 - .3 Testing and adjustment of all components, systems and sub-systems.
 - .4 Adjustment and securing of all adjustment devices such as dampers, balancing valves, etc.
 - .5 Adjustment and calibration of all control and safety devices.
 - .6 Adjustment and calibration of air volume control devices on air handling systems.
 - .7 Adjustment and securing of all air inlet or outlet balancing devices.
 - .8 Adjustment and setting of automatic controls for accurate response and precise sequencing.
 - .9 Confirmation that all pressure maintenance, alarm and trouble annunciation devices on the fire protection systems are properly adjusted, and properly connected to the fire alarm panel. These tests are not to be commenced until the fire alarm panel is complete and tested as specified in Division 26 of the specification. Certification of the devices provided under Divisions 21 22 23 25 are to be completed by actual operation of the fire protection system. Testing continuity of the device and wiring is not satisfactory.
 - .10 Adjustment of vibration isolators and earthquake restraints.
 - .11 Operation of fire dampers.
- .3 Receipts from Departmental Representative for all equipment provided to the building operator under this Division, including but not limited to the following:
 - .1 Chemical - Hydronic system
 - .2 Circuit setter equipment & tables
 - .3 Spare sprinkler heads
 - .4 Spare filters - identify by system and unit
- .4 Provide written reports on all necessary systems. Do not proceed to the next phase, without written acceptance of this phase, by the Department representative.

3.4 Commissioning Phase Three - Verification of Commissioning

- .1 Verification of commissioning by the Departmental Representative shall not commence until Phase Two Commissioning is totally complete.
- .2 Operate and demonstrate entire system operation with the Departmental Representative present. The Departmental Representative will indicate acceptance of the tests by initialling items on the checklists. The commissioning process will not be considered complete until all system components are tested and accepted in concert with all other systems.
- .3 Submit test reports, test completion certificates, and related data at the time of requesting the commencement of the verification phase.
- .4 The verification process will include, but not be limited to the following:
 - .1 Locating and demonstrating the opening capability of all access panels, and confirming that the record drawings show these devices in the correct location.
 - .2 Locating and demonstrating the accessibility and setting of all hydronic balancing valves, and confirming that the record drawings show these devices in the correct location.

- .3 Locating and demonstrating the accessibility and setting of all air flow balancing dampers, and confirming that the record drawings show these devices in the correct location.
- .4 Locating and demonstrating proper operation of fire dampers, randomly selected by the Department representative, and confirming that the record drawings show these devices in the correct location.
- .5 Demonstrate noise levels from air handling systems in all modes of operation.
- .6 Verifying operation of all systems and components in all sequences, and under varying loads. The commissioning agent will require thorough knowledge of the control system in order to adjust and reset operating ranges in order to force the systems into required demonstration modes.
- .7 Verifying all DDC system features.
- .8 Verifying all mechanical systems control features.
- .9 Verifying correct operation of all refrigeration, and heat generating systems.
- .10 Demonstration of all pump systems, including pressure and amperage readings. The commissioning agent must have performance curves available during the demonstration, for comparison of the pressure and amperage readings.
- .11 Demonstration of all coils and heat exchange systems, including both side inlet and outlet temperature readings. The commissioning agent must have performance specifications available during the demonstration, for comparison of the temperature readings.
- .12 Demonstration of inlet and outlet temperature readings on heat transfer elements, randomly selected by the Department representative. The commissioning agent must have performance specifications available during the demonstration, for comparison of the temperature readings.
- .13 Operation of all unit heaters and forced flow heaters.
- .14 Operation of all exhaust fan systems.
- .15 Fill status and pressure settings on expansion tanks.
- .16 Operation of humidification and de-humidification systems.
- .17 Operation and sequencing of boilers, including flue gas tests, and all safety devices.
- .18 Demonstration of domestic water re-circulation and tempered water control systems.
- .19 Demonstrate position and proper sequence for HVAC storage tank level control and alarm floats.
- .20 Demonstrate position and proper sequence for firefighting reservoir level control and alarm floats.
- .5 Provide written reports on all necessary systems. Do not proceed to the next phase, without written acceptance of this phase, by the Department representative.

3.5 Commissioning Phase Four - Demonstration, Training, Handover and Acceptance

- .1 Demonstration to the Departmental Representative shall not commence until Phase Three services are totally completed.
- .2 Substantial Performance will not be considered until the successful completion of Phase Four Commissioning.
- .3 The process of Demonstration, Training, Handover and Acceptance is a planned process, requiring pre-approval of the plan and stages, and a signed statement of Acceptance by the Departmental Representative at the completion of each stage of the process.

- .4 As the project moves close to the final stages, a formal dialogue will be established by the Departmental Representative and the Contractor, in order to schedule times, dates and required personal for systems and equipment commissioning, demonstration and training. No Commissioning, Demonstration, or Training session shall occur at the same time as any other Commissioning, Demonstration, or Training session.
- .5 The Departmental Representative will attend on the site on a scheduled basis, to inspect and review the installation. The Contractor shall arrange for all necessary and specified personal and equipment specialists to be in attendance for purposes of demonstrating and training.
- .6 Obtain a signed statement from the Departmental Representative certifying that the demonstration and instruction have been given to his satisfaction.
- .7 Obtain a list of all persons attending commissioning, demonstration, or training sessions, including their signatures and job title.
- .8 If systems are deemed complete and acceptable by the Department Representative and the building operator, the Departmental Representative will signify acceptance by signing a formal handover receipt relating to the subject system or equipment. If systems are not deemed complete and acceptable by the Department Representative, the Contractor will re-schedule the session for a future time. The costs of the Departmental Representative and building operator's attendance at this or other subsequent sessions will be charged to the Contractor.
- .9 The Departmental Representative will issue lists of required submissions, receipts and acceptance forms, for execution by the contractor. Refer to sample forms for Handover and Acceptance included in this Section.
- .10 The services to be provided by the commissioning agent and other contractors in this phase include, but are not limited to the following:
 - .1 Training in the normal, abnormal and emergency operation of all systems provided under this Division.
 - .2 Training in the programming, normal, abnormal and emergency operation of the control system.
 - .3 Review and instruction in the normal maintenance and operation of the fire protection systems. This training is to include thorough review of the procedures for adjustment and testing of devices, and the procedures to be followed when there is an activation of automatic systems or trouble annunciation.
 - .4 Review of all necessary maintenance procedures of all systems provided under this Division.
 - .5 Provision of a documented maintenance program covering all systems provided or modified under this contract.
 - .6 Review of all documents and reports created during Phases One, Two, and Three of the Commissioning process.
 - .7 Final certification letters from the commissioning agent, balancing contractor, controls contractors, and the Division 21 22 23 25 contractors, that all systems are installed and operating, providing the intended service to the building.

3.6 Commissioning Phase 5 Seasonal Verification

- .1 Contractor and commissioning agent to allow for additional field reviews to verify seasonal performance within the warranty period.

SECTION 23 07 13 – DUCT INSULATION

1. GENERAL

1.1 Work Included

- .1 Duct thermal insulation on new ducts.
- .2 Duct acoustic insulation on new ducts.
- .3 Adhesives, tie wires, tapes.
- .4 Recovering.

1.2 Quality Assurance

- .1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.
- .2 The British Columbia Insulation Contractors Association (BCICA) Standards Manual for Mechanical Insulation, latest edition, together with authorized additions and amendments, shall be used as a reference standard and shall form part of this project specification. The Contractor responsible for mechanical installation work shall keep a copy of the above manual available for reference.
- .3 The Departmental Representative may open, cut or remove sections of insulation in order to examine the installation. Make all repairs necessary that may result from this examination.
- .4 Furnish the Departmental Representative with a Quality BCICA Assurance Certificate for the mechanical insulation work at Substantial Performance of the Work in accordance with the BCICA Quality Assurance Certificate Program (QACP).
- .5 To qualify for the QAC Program, workmanship must conform to the latest QAC Standards as published in the BCICA Quality Standards for Mechanical Insulation (Commercial and Institutional Buildings) Manual (QSMIM).
- .6 Only materials that conform to the standards listed in the QSMIM and accepted by BCICA may be used in the QAC Program.
- .7 Materials must be installed by tradespersons with a Red Seal or TQ designation in the Heat and Frost trade, and/or registered apprentices / helpers supervised by qualified journeypersons.
- .8 Inspection as required under the QAC Program is to be performed by an independent inspector specifically "designated" by BCICA for the purpose of inspecting QAC Program.

1.3 Job Conditions

- .1 Deliver material to job site in original unbroken factory packaging, labelled with manufacturer's density and thickness.
- .2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.4 Alternatives

- .1 Alternative insulations are subject to approval. Alternatives shall provide the thermal resistance within 10% of specified at normal conditions as material specified.

1.5 Definitions

- .1 Supply air duct includes all discharge duct connected to air handlers, furnaces, fan coils, heat pumps, rooftop units.

1.6 Submittals - Prior to Construction

- .1 Trades Qualification certificates.
- .2 Insulation shop drawings, including but not limited to:
 - .1 Insulation Material
 - .2 Insulation Values
 - .3 MSDS Information

1.7 Acceptable Insulation Contractors

- .1 Contractor must be a member of the British Columbia Insulation Contractors Association.

2. PRODUCTS

2.1 General

- .1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed. Adhesives, coatings and sealers shall be waterproof.
- .2 Recovering Jackets ULC listed treated cotton fabric.
- .3 Pre-covered, preformed insulation complete with foil or Kraft all-purpose jacket.

2.2 Materials

- .1 Exposed Rectangular Ducts: Rigid fibrous glass insulation, "K" value at 24 deg. C maximum 0.035 w/m deg. C (0.24 btu/in/sq. ft. /deg. F/hr) with factory applied reinforced aluminum foil vapour barrier.
- .2 Exposed Round Ducts: Flexible fibrous glass insulation, "K" value at 24 deg. C maximum 0.038 w/m deg. C (0.26 btu/in/sq. ft. /deg. F/hr) with factory applied reinforced aluminum foil vapour barrier.
- .3 Concealed Round Ducts and Concealed Rectangular Ducts: Flexible fibrous glass insulation, "K" value at 24 deg. C maximum 0.038 w/m deg. C (0.26 btu/in/sq. ft. /deg. F/hr) with factory applied reinforced aluminum foil vapour barrier.
- .4 Acoustic Lining: Fiberglass insulation with "K" value at 24°C maximum 0.035 w/m deg. C (0.26 btu/in/sq. ft. /deg. F/hr) absolute roughness of exposed surface not to exceed 0.033 mm coated to prevent fibre erosion at air velocities up to 2.0 m/s, 24 kg/m³ minimum density. All substrate material to be non-darkened, contrasting colour from liner layer.

3. EXECUTION

3.1 Preparation

- .1 Do not install covering before ductwork and equipment has been tested and approved.
- .2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation - General

- .1 Insulate exhaust ductwork within 1,500 mm of insulated surface penetration.
- .2 Insulate all supply duct unless it is exposed in the area it serves.
- .3 Insulate all unheated outdoor air, combustion air, and ventilation air inlet ducting.
- .4 In non-fire rated surfaces, ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material properly sealed.
- .5 Finish insulation neatly at hangers, supports and other protrusions.

- .6 Locate insulation or cover seams in least visible locations.
- .7 Unless otherwise noted do not provide external insulation on supply, return or exhaust duct exposed in the area it serves. Provide acoustic liner where indicated.
- .8 Where existing insulated ductwork has been capped, provide equivalent insulation at the capped location. Ensure that new and existing insulation is continuous and that the vapour barrier is intact.
- .9 Insulation thickness shall not be compressed or altered in any way.

3.3 Rectangular Ducts - Concealed

- .1 Secure Insulation to ductwork using one of the following methods:
 - .1 Flare Staples installed on 50 mm centres. Cover staples with 75 mm wide foil face tape to maintain vapour barrier.
 - .2 Polypropylene twine or 16 gauge annealed tie wire, spiral wound or half hitched at 400 mm centres
- .2 For ducts 600 mm and larger, also use insulation pins on 300 mm centres. Pins shall be secured by capacitor welder. The use of adhesive pins is not permitted.
- .3 It is not permitted to use only adhesives to secure insulation.
- .4 Secure and seal all seams and joints with 75 mm foil face tape.
- .5 Ensure that the vapour barrier is complete and intact. Seal all openings.

3.4 Round Ducts - Concealed

- .1 Secure Insulation to ductwork using one of the following methods:
 - .1 Flare Staples installed on 50 mm centres. Cover staples with 75 mm wide foil face tape to maintain vapour barrier.
 - .2 Polypropylene twine or 16 gauge annealed tie wire, spiral wound or half hitched at 400 mm centres
- .2 It is not permitted to use only adhesives to secure insulation.
- .3 Secure and seal all seams and joints with 75 mm foil face tape.
- .4 Ensure that the vapour barrier is complete and intact. Seal all openings.

3.5 Ducts - Exposed

- .1 Generally comply with the requirements of concealed ducts except modify to allow application of canvas recovering.
- .2 Recovering to be smooth and ready for painting. Painting is specified in other Divisions.

3.6 Acoustic Lining

- .1 Apply to interior of ducts where shown.
- .2 Secure insulation to ductwork with insulation pins on 400 mm centres. Pins secured by adhesive or capacitor welder. Ensure pin welds do not damage duct zinc coating protection. Cut off excess fastener length and cover with brush coat of sealer.
- .3 Provide vapour barrier located on the warm side for outside air intakes.
- .4 Seal exposed edges with heavy coat of sealing material.
- .5 Ducts with equivalent acoustic insulation do not require external thermal insulation.
- .6 Use 25 mm thick insulation unless otherwise noted.

3.7 Insulation Thickness Schedule

.1 Ducts and System		Thickness
		mm
.1	Combustion Air Duct	25
.2	Outside Air Intake Ducts	25
.3	Supply Air Ducts Warm Space	25
.4	Exhaust Air Ducts	25
.5	Return Air Ducts Warm Space	Not Required

1. GENERAL

1.1 Work Included

- .1 Piping insulation on new and renovated pipes.
- .2 Equipment insulation on new and renovated equipment.
- .3 Adhesives, tie wires, tapes.
- .4 Recovering.

1.2 Quality Assurance

- .1 All workers engaged in the application of insulation shall be journeymen, or indentured apprentices working under a journeyman who is on the site. Trades Qualification certificates must be submitted prior to commencing work and must be on site for inspection.
- .2 The British Columbia Insulation Contractors Association (BCICA) Standards Manual for Mechanical Insulation, latest edition, together with authorized additions and amendments, shall be used as a reference standard and shall form part of this project specification. The Contractor responsible for mechanical installation work shall keep a copy of the above manual available for reference.
- .3 Furnish the Departmental Representative with a Quality BCICA Assurance Certificate for the mechanical insulation work at Substantial Performance of the Work in accordance with the BCICA Quality Assurance Certificate Program (QACP).
- .4 To qualify for the QAC Program, workmanship must conform to the latest QAC Standards as published in the BCICA Quality Standards for Mechanical Insulation (Commercial and Institutional Buildings) Manual (QSMIM).
- .5 Only materials that conform to the standards listed in the QSMIM and accepted by BCICA may be used in the QAC Program.
- .6 Materials must be installed by tradespersons with a Red Seal or TQ designation in the Heat and Frost trade, and/or registered apprentices / helpers supervised by qualified journeypersons.
- .7 Inspection as required under the QAC Program is to be performed by an independent inspector specifically "designated" by BCICA for the purpose of inspecting QAC Program.

1.3 Job Conditions

- .1 Deliver material to job site in original unbroken factory packaging, labelled with manufacturer's density and thickness.
- .2 Perform work at ambient and equipment temperatures as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.4 Alternatives

- .1 Alternative insulations are subject to approval. Alternative shall provide the thermal resistance within 10% of specified at normal conditions as material specified.

1.5 Definitions

- .1 Heating piping: All supply and return piping in hydronic service, carrying heating water at temperatures over 35°C (95°F), and all supply and return piping serving heat recovery equipment such as coils, no matter what temperature.

1.6 Submittals - Prior to Construction

- .1 Trades Qualification certificates.
- .2 Insulation shop drawings, including but not limited to:
 - .1 Insulation Material
 - .2 Insulation Values
 - .3 MSDS Information

2. PRODUCTS

2.1 General

- .1 Adhesives, Insulation, Coatings, Sealers and Recovering Jackets: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed. Adhesives, coatings and sealers shall be waterproof.
- .2 PVC Recovering for all piping.
- .3 Mechanical Protection Jackets Equipment Interior: Preformed close crimped 26 gauge aluminum.

2.2 Materials – Pipe General

- .1 Hot Water Piping: Fine fibrous glass insulation with factory applied general purpose jacket, moulded to conform to piping, "K" value at 24 degrees Celsius maximum 0.035 w/m deg. C, (0.24 btu/in/sq. ft./deg. F/hr).
- .2 Vents (Concealed): Flexible fibrous glass insulation, "K" value at 24 degrees Celsius maximum 0.038 w/m deg. C (0.26 btu/in/sq. ft./deg. F/hr).

2.3 Materials – Hot Equipment

- .1 Rigid fibrous glass insulation, "K" value at 24 degrees Celsius maximum, 0.035 w/m deg. C (0.24 btu/in/sq. ft./deg. F/hr).

2.4 Refrigeration Line Insulation

- .1 Foam cell insulation used indoors or in confined locations shall have a fire spread rating of 25 and a smoke spread rating of 50.
- .2 Plastic of closed cell structure, "K" value at 75 degrees F maximum 0.28 btu*in/sq. ft./deg. F/hr), maximum water vapour transmission rating of 0.1 perms.

3. EXECUTION

3.1 Preparation

- .1 Do not install covering before piping and equipment has been tested and approved.
- .2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

- .1 Finish insulation in a workmanlike fashion, in accordance with published trade guidelines. Insulation finish must be tidy and without creases. Cut edges must be straight and either parallel or perpendicular to piping. Do not modify PVC or other recovering fittings for any purpose other than that intended by the manufacturer. Replace abraded or discoloured insulation sections, do not patch. Do not leave exposed fibreglass.
- .2 Insulation on piping that penetrates non rated walls is to be continuous through the sleeve or penetration. Insulation on piping that penetrates rated walls must be dis-continuous at the rated surface, and not compromise the rating of the penetration.

- .3 In penetrations or sleeves, pack around pipes with fireproof self-supporting insulation material, properly sealed.
- .4 Finish insulation neatly at hangers, supports and other protrusions.
- .5 Locate insulation or cover seams in least visible locations.
- .6 Provide PVC recovering on exposed insulation throughout, including equipment rooms.
- .7 Do not install and seal vapour proof insulation if ambient air has high humidity.
- .8 Where existing insulated piping services have been capped, provide equivalent insulation at the capped location. Ensure that new and existing insulation is continuous and that the vapour barrier is intact.
- .9 Insulation thickness shall not be compressed or altered in any way.

3.3 Domestic Water and Non-Specified Piping - Hot and Cold.

- .1 Do not insulate valves, unions, flanges, strainers, flexible connections and expansion joints, unless otherwise specified.
- .2 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.
- .3 Exposed and concealed fittings: Apply pre-formed PVC fitting covers over insulation material before applying recovering. Provide butt end PVC fittings on exposed pipe and fittings
- .4 Exposed piping: Provide PVC recovering on all exposed piping including mechanical rooms.
- .5 Concealed fittings: Apply glass fabric wrap material around loose batt insulation. Terminate insulation neatly.

3.4 Heating Water and Glycol Piping

- .1 Do not insulate valves, unions, flanges, strainers, flexible connections and expansion joints, unless otherwise specified.
- .2 Cover elbows, tees and similar fittings with equivalent thickness of insulation material.
- .3 Exposed and concealed fittings: Apply pre-formed PVC fitting covers over insulation material before applying recovering. Provide butt end PVC fittings on exposed pipe and fittings.
- .4 Concealed fittings: Apply glass fabric wrap material around loose batt insulation. Terminate insulation neatly.
- .5 Exposed piping: Provide PVC recovering on all exposed piping including mechanical rooms
- .6 Do not insulate within radiation enclosures.

3.5 Plumbing Vents

- .1 Insulate vent piping within 1,500 mm of insulated surface penetration.
- .2 Adhere flexible insulation with adhesive applied in 150 mm wide strips on 400 mm centres. Provide polypropylene twine, spiral wound or half hitched at 400 mm centres for securing insulation until adhesive sets. Butt insulation and seal joints and breaks with 100 mm lap of scrim foil tape adhered over joint.

3.6 Refrigerant Piping

- .1 Cover fittings and valves with equivalent thickness of insulation material.
- .2 Apply with edges tightly butted.
- .3 Seal joints with vapour barrier tape or sealer.
- .4 Provide Aluminum jacketing over insulation installed outdoors.

3.7 Insulation Thickness – Above Ground Piping

Pipe System	Pipe size mm	Thickness mm
.1 Domestic Cold Water	All Sizes	25
.2 Domestic Hot Water	All Sizes	25
.3 Re-circulated hot water	All Sizes	25
.4 Plumbing Vents	All Sizes	25
.5 Hot water heating	up to 50mm	25
.6 Hot water heating	64mm and larger	38
.7 Hot Equipment	All Sizes	50
.8 Condensate Lines from Fan coils	All Sizes	25
.9 Refrigerant Suction	All Sizes	13

1. GENERAL

1.1 Work Included

- .1 Chemical treatment of glycol heating water systems.
- .2 Chemical pot feeder and accessories.
- .3 Chemical feed pump and control system.
- .4 WHMIS Documentation.
- .5 Disinfection of domestic water mains.

1.2 Quality Assurance

- .1 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. Agency shall take full responsibility for providing suitable working systems.
- .2 Notify the Departmental Representative prior to commencing treatment, testing or cleaning operations.
- .3 Confirm all chemicals used are applied and disposed of in compliance with all guidelines, codes, regulations and requirements of Federal, Provincial, and local governments and local sewage and storm water disposal utilities.

1.3 Submittals – Prior to Construction

- .1 Submit technical information, including proposed chemicals, quantities, and calculations, procedures and equipment to be supplied. Provide written operating instructions and system schematics.
- .2 Provide Material Safety Data Sheets with all chemicals. Provide one complete set posted on site when material is delivered to site. Provide complete sets for the Maintenance Manuals.
- .3 Do not proceed on treatment until tests on utility water are submitted. No progress claims for any category of work specified under Division 23 will be approved until acceptable reports are submitted and approved.
- .4 Provide qualifications and licenses of technicians undertaking chemical work, or handling chemicals.

1.4 Submittals – Prior to Substantial Performance

- .1 Provide written report containing log and procedure of system cleaning giving times, dates, problems encountered and condition of water.
- .2 Submit written report containing results of tests and list of chemicals added.
- .3 Provide the required number of visits to check treatment, take samples and adjust and upgrade proper addition of treatment.

1.5 Acceptable Manufacturers

- .1 Companies whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Enercon, Chem-Aqua, IPAC Chemicals, Dearborne.

2. PRODUCTS

2.1 Cleaners

- .1 System Cleaner: Alkaline compound which in solution removes grease and petroleum products.

2.2 Chemical Safety Materials

- .1 Provide wall mounted file folder holder to contain all safety and operating instructions for all chemicals provided.
- .2 Provide clear typewritten instructions, separate from the normal WHMIS or manufacturer details, clearly and concisely, describing the emergency procedures to be followed if chemicals are spilled on the floor, or on a worker. These instructions are to be on brilliant red or other suitable coloured paper, plastic coated and wall hung in a suitable location in the boiler room or mechanical room where chemicals are handled and stored.

2.3 Hydronic Treatment - Closed systems - High Temperature

- .1 Precipitation and scaling:
 - .1 Phosphonate where indicated by high concentrations of dissolved calcium compounds and high iron oxide concentration.
 - .2 Dispersants where indicated by high un-dissolved calcium compounds and other mineral concentrations.
 - .3 Surfactants where internal metals properties require filming protection or where chemical interventions are destructive or non-effective.
 - .4 Acid to raise saturation concentration.
 - .5 Chemical to contain multiple active chemicals as required for treatment of target precipitating material determined by test.
- .2 Corrosion:
 - .1 Chromates not approved.
 - .2 Molybdate based or filming compounds, or oxygen scavenging compounds.
- .3 Test strip.
 - .1 Coupons for monitoring and confirming effectiveness of chemical treatment program.
- .4 Test Submittals: Tests identifying water chemistry, hardness, concentration of calcium carbonate, calcium phosphate, magnesium silicate, iron oxide, total dissolved solids, pH, alkalinity, etc.
- .5 Program Submittals: Proposed chemicals and program for treatment, expected consumption and frequency, monitoring and testing program, disposal methods, calculation of blow-off rate. Provide calculations and data to support recommendations.
- .6 Enercon .

2.4 Glycol Systems

- .1 Refer to Section 15705, Glycol Systems for materials.
- .2 Test Submittals: Water tests identifying water chemistry, pH, alkalinity, etc.
- .3 Program Submittals: Proposed chemical and program for treatment, expected consumption and frequency, monitoring and testing program, disposal methods. Provide calculations and data to support recommendations.
- .4 Provide additional inhibitors or other products where required by the premixed inhibited glycol percentage.
- .5 Enercon.

2.5 Equipment

- .1 Pot Feeder: 7.5 litre capacity cast iron or welded steel with quick opening cap.

2.6 Test Kits

- .1 Provide test kits as required to determine proper systems treatment and not limited to the following:
 - .1 Boiler Water Treatment Test Kit: To determine proper treatment and blow down.
 - .2 Closed System Test Kit: To determine proper concentration of closed system treatment.
- .2 Test kits are to be exactly identical in sophistication and technical content to the kits used by the chemical equipment supplier.

3. EXECUTION

3.1 General

- .1 Provide sufficient material to adequately treat systems for period of the contract.
- .2 Provide services required to obtain samples of utility water. Perform tests to provide full chemical analysis.
- .3 Do not proceed on treatment until tests on utility water and existing water are submitted.
- .4 Perform tests and analysis at time of shop drawing submittal and at time of Substantial Completion.
- .5 If necessary, provide temporary water meters to determine capacity in each system.
- .6 Notify sewage treatment utility when anticipating disposal of chemical into utility system.
- .7 Obtain and submit all permits from regulatory agencies and utilities.
- .8 Do not dispose chemicals in storm drain system.
- .9 Do not dispose chemicals in sanitary sewer disposal system, without written permission from utility.

3.2 Pot Feeder

- .1 Provide new pot feeders on each system.
- .2 Install isolating and drain valves and necessary piping.
- .3 Install around globe valve downstream of circulating pumps unless otherwise shown on drawings.
- .4 Pot feeders are to be installed complete with small diameter piping extensions as required, in order to position the feeder no more than 1,200 mm from floor.

3.3 Disinfection

- .1 Commence disinfection procedures at the completion of water service piping.
- .2 Close main water service valve at the property line. Introduce chlorine in concentrations necessary and as recommended by the material supplier.
- .3 Perform tests to determine residual chlorine concentration at levels necessary to provide disinfection service.
- .4 After a minimum of two days of contact, or as directed by the Department representative, flush systems thoroughly, and provide tests to determine chlorine concentrations have been lowered to safe levels.
- .5 All disinfection procedures to be coordinated and approved by the water utility.

3.4 Systems Cleaning

- .1 Remove strainer screens during cleaning. Protect or remove control devices during cleaning. Terminal control valves shall be in open position during cleaning.

- .2 System pumps may be used for cleaning provided pumps are dismantled, inspected, worn parts repaired and new gaskets and seals installed as necessary.
- .3 Inspect piping and tanks, clean sludge and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- .4 Thoroughly flush all water piping, so that it is free from all scale, sediment, etc. as soon as possible after the system is filled.
- .5 Remove or bypass control valves and balancing valves during flushing. Do not flush through coils, heat pumps or other terminal devices.

3.5 Hydronic Treatment - Closed systems - High Temperature

- .1 Concentration of Nitrate based treatment to be determined by the Chemical Treatment Specialist on site at the time installation.
- .2 Closed system treatment introduced through pot feeder when required or indicated by test.
- .3 Test existing water and provide written report.
- .4 Submit report of existing domestic water conditions to building operator and Departmental Representative. Include chemical analysis stating effect of time, past treatment history or external events such as leaks and make up, or unanticipated chemical reactions.
- .5 If water from an alternative source is deemed to be required, this will be considered as an extra to the contract.
- .6 Develop and provide program and materials for maintaining or adjusting chemical treatment to control and remove target minerals and compounds.
- .7 After receiving approval of the building operator Departmental Representative, adjust chemical concentration as required to attain specified levels.

3.6 Glycol Systems

- .1 Closed system treatment introduced through hand pump and glycol batch tank, when required or indicated by test.
- .2 Test solution for specific gravity (freeze protection) and water chemistry, and provide written report.
- .3 Submit report of existing domestic water conditions, chemistry and freeze protection to building operator and Departmental Representative. Include chemical analysis stating effect of time, past treatment history or external events such as leaks and make up, or unanticipated chemical reactions.
- .4 If water from an alternative source is deemed to be required, this will be considered as an extra to the contract.
- .5 Develop and provide program and materials for maintaining or adjusting chemical treatment to control and remove target minerals and compounds.
- .6 After receiving approval of the building operator and Departmental Representative, adjust chemical concentration as required to attain specified levels.

1. GENERAL

1.1 Work Included

- .1 Manual and automatic air vents.
- .2 Air separators.
- .3 Relief valves.
- .4 Combination valves and fittings.
- .5 Sight flow indicators - water.
- .6 Side stream filter and accessories.

1.2 Quality Assurance

- .1 Comply with Provincial Regulations and have CSA approval.

1.3 Submittals - Prior to Construction

- .1 Provide shop drawings and schedules of manufactured products for review and inclusion in Operating and Maintenance Manuals.

1.4 Acceptable Manufacturers

- .1 Manufacturers of air separators whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Sarco.

2. PRODUCTS

2.1 General

- .1 Unless otherwise noted, all hydronic components shall be suitable for a minimum working pressure of 862 kPa, (125 psi)

2.2 Manual Air Vents

- .1 Manufactured brass body, soldered or brazed construction, threaded connection. Pressure and temperature rated for service.

2.3 Automatic Air Vents

- .1 Provide automatic washer type, all brass with hydroscopic fibre discs, vent ports adjustable cap for manual shut off and integral spring loaded ball check valve to prevent water leakage. Pressure and temperature rated for service.

2.4 Relief Valves

- .1 Provide ASME rated direct spring loaded type, lever operated nonadjustable factory set discharge pressure as indicated.

2.5 Sight Flow Indicators – Water

- .1 Single glass window, bronze body, ABS impeller.
- .2 Suitable for pressure twice that of working pressure, minimum 860 kPa (125 psig).
- .3 Suitable for temperature 90 deg. C (200 deg. F).

2.6 Side Stream Filter

- .1 Body: Heavy duty, type 304 stainless steel, cast brass nickel plated head, removable gasketed top, drain valve, 19 mm diameter inlet and outlet threaded fittings.
- .2 Filter: Multiple paper cartridge, disposable, 5 micron, flow rate 1.20 litres per second (20 usgpm), minimum flow.
- .3 Equal to Amtek model ST-3.

3. EXECUTION

3.1 Air Vents

- .1 Provide manual type at system high points.
- .2 Use automatic float type at heating units and system high points not readily accessible for servicing.
- .3 Use automatic washer type for convection type heating units.
- .4 Where large air quantities can accumulate, provide enlarged air collection standpipe.
- .5 For automatic air vents at high level, or in ceiling spaces or concealed locations, provide vent tubing to glycol fill tank.
- .6 Provide ball valve, 12 mm diameter minimum under each manual or automatic vent. Shut off valve is to allow isolation, removal and service of fitting.

3.2 Relief Valves

- .1 Provide relief valves at pressure tanks, low pressure side of reducing valves, heating converters, expansion tanks and where indicated.
- .2 Pipe relief valve to nearest floor drain.
- .3 System relief valve capacity shall equal make up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.
- .4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.3 Side Stream Filter

- .1 Install new filter across hydronic primary or secondary piping. Refer to drawings.
- .2 Provide isolation valves on inlet and outlet, and drain valve to allow filter maintenance with system in operation.
- .3 Provide sight glass indicator on discharge piping.
- .4 Extend piping from connection to a point within 1,200 mm from the floor, to allow service from the floor without a ladder.

1. GENERAL

1.1 Work Included

- .1 Expansion tanks.
- .2 Glycol storage mixing tank.
- .3 Structural supports and earthquake restraints.
- .4 Testing.

1.2 Standards

- .1 Construct pressure tanks to ASME Code for Unfired Pressure Vessels.
- .2 Comply with Provincial Government Regulations.

1.3 Submittals - Prior to Construction

- .1 Submit capacity, dimensions, material, lining, fittings, piping schematics, supports, operating weight, finish.

1.4 Permits and Inspections

- .1 Obtain inspection certificates for pressure vessels from Provincial Authorities.
- .2 Give all necessary notices, obtain all necessary permits, and pay all fees in order that the work may be carried out.
- .3 Furnish any certificates necessary and evidence that the work installed complies with regulations of all authorities having jurisdiction before final certificates are issued.

1.5 Acceptable Manufacturers

- .1 Manufacturers of expansion tanks whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Amtrol, Flexcon, Wessels.
- .2 Manufacturers of glycol storage and mixing tanks whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Axiom.

2. PRODUCTS

2.1 Expansion Tanks - Bladder Type

- .1 Closed type, welded steel, rated for working pressures of 862 kPa, (125 psi), cleaned, prime coated and supplied with steel support saddles.
- .2 Construct tank with necessary tapings for installation of accessories.
- .3 Full acceptance bladder size, butyl rubber bladder material.
- .4 Provide quick connect air inlet of automotive tire valve type and tank drain.
- .5 Precharge shall be 83 kPa (12 psi)
- .6 Drain valve.
- .7 Provide pressure relief valve and automatic cold water fill assembly, complete with pressure reducing valve, reduced pressure double check back pressure valve, with test cocks, strainer, water meter, vacuum breaker, and valved bypass.

2.2 Glycol Mixing Tank (Automatic)

- .1 Closed type, 208 liter (55 US gal.) tank with pressure control, adjustable pressure regulating valve, pressurization pump, pressure gauge, check valve and union connection.
- .2 Pressurization pump with thermal cut-out capable of supplying 0.06 l/s at 345kPa.
- .3 Low fluid level contact for connection to BMS.

3. EXECUTION

3.1 General

- .1 Support tanks inside building from building structure, as indicated on drawings.
- .2 Locate tanks as indicated on the drawings.
- .3 Secure all floor, wall and ceiling mounted tanks to withstand lateral and vertical movement due to earthquake.

3.2 Expansion Tanks – Bladder or Diaphragm Type

- .1 Submit calculations on required pressure for bladder type tank, and confirm that the air charge is preset and correct prior to requesting approval to open water valves.
- .2 Complete and verify the pre-charge prior to opening tank valves to the system.
- .3 Obtain permission from the Departmental Representative or the Commissioning Agent prior to opening the tank valves to the system.
- .4 After receiving permission to open the valves, follow manufacturers recommendations for tank charging and commissioning. Submit report on final pressure.
- .5 Failure to follow the above procedure will result in the tank being disconnected from the system and drained so that the precharge can be adjusted. Once the precharge is adjusted, the tank will then be reconnected to the system.
- .6 Set pressure relief valve as indicated in schedules.
- .7 Set pressure reducing valve on make-up water line or glycol hydronic pressurization tank as directed by Commissioning Agent.
- .8 Provide a pressure and temperature relief valve for each expansion tank, located between the isolation valve and the tank, size equal to the expansion tank connection, set pressure equal to boiler relief valves.

3.3 Glycol Mixing Tank

- .1 Connect transfer pump discharge to glycol return line. Provide gate valve and check valve.
- .2 Provide valved and capped tee connection for drain purposes.
- .3 Mount hydrometer on side of tank.
- .4 Provide glycol solution as specified.

3.4 Capacities

- .1 Refer to tank schedule.

1. GENERAL

1.1 Work Included

- .1 Ductwork and plenums.
- .2 Fasteners.
- .3 Sealants.
- .4 Flexible ducts

1.2 Definitions

- .1 Duct sizes are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.
- .2 Low Pressure: Static pressure in ducts less than 0.50 kPa (2" wg) and velocities less than 10 m/s (2,000 fpm).

1.3 Quality Assurance

- .1 Ductwork and methods shall meet the requirements of:
 - .1 British Columbia Building Code.
 - .2 NFPA 90A Air Conditioning and Ventilation Systems.
 - .3 All other local codes and requirements.
- .2 Fabricate in accordance with ASHRAE and SMACNA manuals.

1.4 Job Conditions

- .1 Store ductwork on site or in warehouse in dry, heated locations. Cover all opening ductwork with polyethylene sheets and seal with tape.

2. PRODUCTS

2.1 Materials

- .1 Ducts: Galvanized steel lock forming quality, having galvanized coating of 0.38 kg/m² on both sides.
- .2 Fasteners: Use sheet metal screws, rivets and bolts.
- .3 Sealant: Water resistant, fire resistive, compatible with mating materials,.

3. EXECUTION

3.1 Fabrication

- .1 Unless otherwise indicated, branch ductwork serving a single diffuser or grille shall be sized equal to the nominal grille size or the diffuser neck size.
- .2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 300 mm, cross break for rigidity. Open corners are not acceptable.
- .3 Lap metal ducts in the direction of air flow. Ensure the interior is smooth.
- .4 Construct tees, bends and elbows with radius of not less than 1.5 times the width of the duct on centre line. Where this is not possible, and where rectangular elbows are used, provide approved type of air foil turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type.
- .5 Increase duct sizes gradually, not exceeding 15 degrees divergence.
- .6 Rigidly construct metal ducts with joints mechanically tight, substantially air tight, braced and stiffened so as not to breathe, rattle, vibrate or sag.

- .7 Ducts subject to noise transfer or vibration are to be reinforced to prevent duct vibration and sound transmission. Provide cold rolled steel angle bar, not sheet metal break angle, bolted or riveted to the duct in parallel or cross fashion to completely eliminate duct vibrations and sound transmissions.
- .8 Provide easements where low pressure ductwork conflicts with piping or structure, with easements not exceeding 10% of the duct area. Where easements are not required, split ductwork into two ducts maintaining original duct area.
- .9 Provide necessary baffling in mixed air plenums to ensure good mixed air temperature with variations of not more than plus or minus 3°C under all operating conditions.

3.2 Installation

- .1 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can and spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring. Provide sealing grommet flush plug for holes.
- .2 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .3 Supply, return and exhaust ducts shall be sealed with approved sealant. Sealant shall be applied to all joints and connections of all descriptions in such a manner that no air may enter or leave the ductwork through a joint or connection. The Departmental Representative must be satisfied that no joint or connection will leak. If necessary, the ductwork shall be pressurized with the specified equipment to demonstrate that there are no leaks. Tape seal only joints are not approved.
- .4 In concealed spaces where conditions will not permit metal ducts, diffusers or troffer boots may be connected to low pressure ducts with flexible duct maximum length 1,000 mm. Hold in place with strap or clamp.
- .5 At each point where ducts pass through partitions, seal joints around duct with non-combustible material.
- .6 Do not install new or renovated ductwork in a position that would affect the spray pattern of new or existing sprinklers heads. If such a configuration is required, notify the Departmental Representative and await instructions. Failure to notify the Departmental Representative in advance of installation of the duct will leave the costs to rectify the situation solely as the responsibility of the contractor.

3.3 Flexible Ducts

- .1 General HVAC Supply and Return: Length shall be maximum 300 mm, with maximum 15° offset from duct axis. Do not use flexible ductwork in place of elbows. Support as necessary to prevent sagging. Fasten at each end with plastic strapping and a minimum of three screws.
- .2 Do not install flexible ductwork on exposed ductwork.

3.4 Duct Gauges - General

.1	Rectangular Ducts	gauge	mm
	Maximum Width		
.1	Up to 300 mm	26	0.55
.2	300 mm to 750 mm	24	0.70
.3	760 mm to 1,400 mm	22	0.85
.4	1,400 and over	20	1.01

.2	Rectangular Ducts	gauge
	Maximum Width	
.1	Up to 12 inches	26
.2	13 inches to 30 inches	24
.3	31 inches to 55 inches	22
.4	56 inches and over	20

3.5 Exposed Ductwork

- .1 Install ducts substantially straight and level. All fittings and branch ducts to be installed with tight, well fitted joints.
- .2 All joints to be properly sealed. Sealer to be carefully applied to limit poor appearance of improperly applied sealer.
- .3 Align duct with building lines and structure.
- .4 All exposed duct to be prepared and suitable for painting.

1. GENERAL

1.1 Work Included

- .1 Duct access doors.
- .2 Fire dampers.
- .3 Balancing dampers.
- .4 Back draft dampers.
- .5 Flexible connections.

1.2 Quality Assurance

- .1 Fire dampers shall be UL listed and constructed in accordance with ULC Standard S112 "Fire Dampers".
- .2 Fusible links on fire dampers shall be constructed to ULC Standard S505.
- .3 Demonstrate resetting of fire dampers to authorities having jurisdiction, and to Departmental Representative's representative.
- .4 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems.
- .5 Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

1.3 Job Conditions

- .1 Store duct accessories on site or in warehouse in dry, heated locations. Cover all openings with polyethylene sheets seal with tape.

1.4 Submittals - Prior to Construction

- .1 Submit shop drawings for:
 - .1 Fire dampers (all types).
 - .2 Balancing dampers (all types).
 - .3 Flexible connections.
 - .4 Access doors.
 - .5 Automatic dampers (each identified unit).

1.5 Acceptable Manufacturers

- .1 Manufacturers of access doors whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Acudor, Milcor, Titus, Canadian Advanced Air, Air-O-Metal, Maxam.
- .2 Manufacturers of fire dampers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Maxam, Titus, Ruskin, Canadian Advanced Air.
- .3 Manufacturers of backdraft dampers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Air-O-Lite, Penn, Westvent, Tamco, Ruskin.
- .4 Manufacturers of automatic dampers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Tamco, Ruskin.

2. PRODUCTS

2.1 Duct Mounted Access Doors

- .1 Rigid and close fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Install minimum 25 mm thick insulation with suitable sheet metal cover frame for insulated duct work.
- .2 Fabricate with two butt hinges with one sash lock, or two sash locks, for sizes up to 250 mm; two hinges and two compression latches without outside handles for sizes up to 600 mm; with additional hinges for larger sizes.

2.2 Fire Dampers

- .1 Galvanized steel or prime coated black steel, weighted or spring loaded to close and lock in closed position when released by fusible link.
- .2 Fire dampers in low pressure duct work may be multi blade offset butterfly or curtain type.
- .3 Curtain fire dampers shall have blades retained in a recess, so that free area of connecting duct work is not reduced.
- .4 Fire dampers shall be dynamic type designed and listed to close with air flow.
- .5 Fusible links shall be set for 30 Celsius degrees above unit high limit setting, or 100 degrees Celsius, whichever is greater.
- .6 Fire dampers on air outlet round throats shall be double flap steel construction, bolted assembly complete with support plate, equal to Canadian Advanced Air Model 0721.

2.3 Gasketed Air Control Dampers – Manual

- .1 Single blade damper of galvanized steel minimum 18 gauge, and provide with quadrants and lock screw.
- .2 Fully flanged seat, 100% of blade perimeter, 20 gauge galvanized, secured and sealed to duct.
- .3 Compressible neoprene or non-combustible felt seals on flange seat to ensure tight shut off configuration.
- .4 Adjustable and lockable quadrant lock on exterior of duct.
- .5 Refer to detail in this section.

2.4 Balancing Dampers

- .1 Multi blade damper: Galvanized steel minimum 16 gauge, provide with quadrants or adjustment rods and lock screw.
- .2 Single blade damper: Galvanized steel minimum 18 gauge, provide with quadrants and lock screw.
- .3 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration. Size on basis of straight air volume proportioning.
- .4 Provide single blade dampers for duct sizes to maximum 250 mm x 760 mm.
- .5 Provide multi blade dampers of opposed blade pattern with maximum blade sizes 300 mm to 1,800 mm. Assemble centre and edge crimped blades in prime coated or galvanized channel frame with approved type hardware.

2.5 Backdraft Dampers

- .1 Multi blade, parallel action gravity counterbalanced back draft dampers with blades in a maximum of 150 mm width, having felt or flexible vinyl sealing edges, linked together in a rattle free manner, and with adjustment devices to permit setting for varying differential static pressures.

- .2 Back draft dampers for exhaust, discharge or relief louvres shall be factory supplied as an integral accessory. Louvre dampers shall be fitted with fully counter balanced unless otherwise noted.
- .3 Back draft dampers for relief-exhaust or other large fans shall be factory supplied as an integral accessory. Dampers shall be fitted with fully counter balanced arms and weights.

2.6 Flexible Connections

- .1 Neoprene coated, flameproof fabric, approximately 50 mm wide, tightly crimped into metal edging strip and attach to ducting and equipment by screws or bolts at 150 mm centres.

2.7 Automatic Dampers

- .1 Automatic dampers shall be in 16 gauge galvanized steel or extruded aluminum multiple blade mounted in 12 gauge, steel or extruded aluminum flanged frame.
- .2 Individual blades shall not exceed 150 mm in width or 1,200 mm in length.
- .3 Provide interlocking edges and compressible seals, oil impregnated bronze or nylon bearings with additional thrust bearings for vertical blades.
- .4 Prime coat steel dampers.
- .5 Dampers for outdoor air, exhaust or relief air service shall have insulated blades.
- .6 Air flow with the damper in the closed position shall not exceed 50 litres per second for each square meter of cross sectional area at a differential pressure of 250 Pa.
- .7 Opposed Blade Dampers: Use for shut off service, modulating service without companion dampers, throttling services.
- .8 Parallel Blade Dampers: Use for mixing or relief service, variable position service with companion dampers.
- .9 Refer to Division 25, Controls for operator and control.

3. EXECUTION

3.1 Access Doors - Duct Mounted

- .1 Provide adequately sized access doors for inspection and cleaning before and after filters, coils, fans, and automatic dampers, at fire dampers and elsewhere as indicated. Review locations prior to fabrication.
- .2 Provide 100 mm x 100 mm quick opening access doors for inspection at balancing dampers.
- .3 Access doors are to be secured to ducts with pop rivets or other means that do not result in sharp screw points or metal barbs within the duct at the door perimeter.

3.2 Fire Dampers

- .1 Confirm rating of devices with ratings of surfaces or separations.
- .2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction.
- .3 Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- .4 Provide fire stop flaps on air outlets penetrating fire rated membranes or surfaces.
- .5 Perform the fire damper drop tests with the Balancing Agent. Remove the fusible links and demonstrate that damper can close freely and without obstruction.
- .6 If any dampers fail perform all repairs and replacements required to ensure that all fire dampers are functional.

3.3 Balancing Dampers

- .1 During the construction process, before duct systems are constructed, review the systems with the balancing and commissioning agents and the commissioning authority. Provide balancing dampers at locations instructed by the balancing and commissioning agents.
- .2 Provide balancing dampers for proper air balancing, whether shown or required, at points on supply, return and exhaust systems, where branches are taken from larger ducts.
- .3 Provide a butterfly balancing damper on each branch duct leading to air supply outlets or inlets. This is in addition to a grille mounted balancing damper if such a device is specified. The branch mounted supply damper is to be within 3 metres of the outlet, but no closer than 1 metre, measured along the duct run. If the required location is behind an inaccessible ceiling or wall, adjust the location to allow easy access, or provide an acceptable access door, after review with the Department representative.
- .4 Use splitter dampers only where indicated.

3.4 Back Draft Dampers

- .1 Install horizontal, gravity balanced back draft dampers on exhaust fan roof curbs, gooseneck roof discharge, roof hood discharge, exhaust duct penetration of roof, or where as shown or noted.
- .2 Install vertical, gravity balanced back draft dampers on exhaust duct penetration of wall, behind relief or exhaust grille, or where as shown or noted.

3.5 Flexible Connections

- .1 Provide flexible connections on inlet and outlet duct connections of fan coils, fans, heat recovery ventilators or other equipment likely to be affected by, or to cause vibration or noise to be transmitted through duct work.
- .2 Provide flexible connection between supply and return ducts.

3.6 Automatic Dampers

- .1 Opposed Blade Dampers: Use for shut off service, modulating service without companion dampers, throttling services.
- .2 Parallel Blade Dampers: Use for mixing or relief service, variable position service with companion dampers.
- .3 Refer to Division 25, Controls for operator and control.

1. GENERAL

1.1 Work Included

- .1 Cabinet exhaust fans.

1.2 Quality Assurance

- .1 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.
- .2 Equipment shall meet the requirements of:
 - .1 British Columbia Building Code.
 - .2 Canadian Standards Association.
 - .3 All other local codes and requirements.
- .3 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 746 watts (1 hp) and 149.2 kw (200 hp), whether in packaged equipment or not, shall comply with the current requirements of the British Columbia Energy Efficiency Standards Regulation, and specifically, CSA C390-93 Energy Efficiency Test Methods for Three Phase Induction Motors.

1.3 Submittals - Prior to Construction

- .1 Shop drawings must be submitted and reviewed by the Departmental Representative prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.
- .2 Submit certified shop drawings for the following:
 - .1 Fan curves and sound data, with fan and system operating point plotted on curves.
 - .2 Fan details, isolation and details.
 - .3 Cabinet construction, gauge, access doors, fasteners.
 - .4 Power wiring diagrams and electrical characteristics.
 - .5 Control wiring diagrams and interfacing details.
 - .6 Maintenance requirements.

1.4 Job Conditions

- .1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters in place, bearings lubricated and fan has been run under close supervision.
- .2 Alternatives Equivalent fan selections shall not decrease motor power, increase noise level, increase tip speed by more than 10% or increase inlet air velocity by more than 20% from that specified.

1.5 Acceptable Manufacturers

- .1 Manufacturers of interior cabinet fans (centrifugal) whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Acme, Greenheck, Nutone, Penn, Twin City, Jenn Air, Lau, Broan, Carnes, ILG, Loren Cook.

2. PRODUCTS

2.1 General

- .1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.
- .2 Provide balanced variable sheaves for motors 11 kw (15 hp) and under, and fixed sheaves for over 15 kw.
- .3 Fans shall be capable of accommodating static pressure variations of +10% with no objectionable operating characteristics.
- .4 Unless otherwise noted, include all motors and drive combinations with electrical characteristics as detailed elsewhere.
- .5 Rate drive as recommended by manufacturer, but minimum 1.5 times power rating of the motor. Submit calculations and technical data with shop drawings, to support drive selection.
- .6 Provide all necessary specialized tools and equipment required to perform speed adjustments on ECM, PSC or other motor types.

2.2 Cabinet Fans

- .1 Resiliently mount multi-blade direct driven fan and motor.
- .2 Cabinet shall be heavy gauge metal with galvanized or baked enamel finish. Provide junction box for wiring. Provide brushed aluminum or baked enamel grille or duct connection on inlet, and duct connection flange on outlet.
- .3 Motors complete with internal thermal protection.
- .4 Accessories:
 - .1 External or internal pre-wired receptacle disconnect fitting.
 - .2 Single blade, rattle free, back draft flap with felt lined blade edges.
 - .3 Variable speed motor and controller where indicated.

3. EXECUTION

3.1 Installation

- .1 Where inlet or outlet is exposed, provide safety screen.
- .2 Provide belt guards on belt driven fans.
- .3 Supply and install sheaves as necessary for final air balancing.
- .4 Set roof mounted fans on curbs 200 mm minimum above roof. Provide acoustic insulation on duct to below roof line and on fan inlet plenum and drip pan for collecting condensation. Curbs are specified under other Divisions of this specification, unless otherwise noted.
- .5 Provide Time Delay Off, Variable Speed Control, Local Control and other switches or motor controls noted on Division 25 schedules or in other Division 23 sections for installation by other trades.

3.2 Performance

- .1 Refer to schedules.

1. GENERAL

1.1 Work Included

- .1 Diffusers.
- .2 Grilles.

1.2 Quality Assurance

- .1 Air flow tests and sound level measurement shall be made in accordance with applicable Air Diffusion Council equipment test codes and ASHRAE Standards.
- .2 Unit ratings shall be approved by the Air Diffusion Council.
- .3 Manufacturers shall certify catalogued performance and ensure correct application of air outlet types.

1.3 Job Conditions

- .1 Review the requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlets.
- .2 Positions indicated are approximate only. Check locations of outlets, and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 Submittals - Prior to Construction

- .1 Physical: For each type of air outlet, louvre, grille, register etc., submit manufacturer certified data on dimensions, mounting method, accessories, dampers, materials, finish, etc.
- .2 Performance: For each type of air outlet, louvre, grille, register etc., submit manufacturer certified data on air flow, sound, pressure loss, velocity.
- .3 Colour chips and samples for powder coated louvres, outlets, fittings and accessories.

1.5 Acceptable Manufacturers

- .1 Manufacturers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Titus Canada, Air Vector, Nailor - Hart, Hart & Cooley, Krueger, Carnes, Price, Tuttle & Bailey.

2. PRODUCTS

2.1 General

- .1 Base air outlet application on maximum space noise level of NC 25.

2.2 Square Panel Ceiling Diffusers - Round Neck Type A

- .1 Square module, size as required for ceiling suspension system or surface.
- .2 One piece, heavy gauge steel centred panel.
- .3 Panel assembly to have a spring lock arrangement to allow removal of the panel for damper inspection and service.
- .4 Unless otherwise specified, all round neck diffusers shall be fitted with screw driver adjustable, arc segment dampers, in addition to any specified duct mounted butterfly dampers.
- .5 Colour: Refer to schedules.

2.3 Grid Ceiling Grilles Type E

- .1 Square module, size as required for ceiling suspension system or surface.
- .2 Pressed aluminum frame, complete with fastening system for frame and core.
- .3 Core of 13 mm wide aluminum strip interconnected to form 13 mm square openings, edged as required for mounting in specified frame.
- .4 Colour: Refer to schedules.

2.4 Wall Grilles - Return or Exhaust Type G

- .1 Heavy gauge steel frame, screw fastening.
- .2 Heavy gauge steel bars in horizontal dimension, 5 mm wide, 11 mm spacing, 0 degree deflection.
- .3 Grille bars supported by heavy gauge flanges secured to the grille frame.
- .4 Grilles to be one piece.
- .5 Colour: Refer to Schedules.

2.5 Duct or Wall Grilles – Supply Type J & Type X

- .1 Steel frame, screw fastening.
- .2 Double or Single deflection steel vanes in horizontal and vertical dimension, 20 mm wide.
- .3 Adjustable vanes supported by heavy gauge pins, nylon or composition bushings to make vanes tight and rattle free. Outside bars in vertical dimension.
- .4 Grilles to be one piece.
- .5 Colour: Refer to Schedules.

2.6 Door Grilles Type K

- .1 Heavy gauge steel flange frame, back flange frame, screw fastening.
- .2 Core: Heavy gauge steel, inverted vee or chevron section bars.
- .3 Coordinate with door type and thickness.
- .4 Colour: Refer to schedules.

3. EXECUTION

3.1 General

- .1 Paint ductwork visible behind air outlets, flat black.
- .2 Provide fire rated material, either blanket or rigid board, with rating equal to ceiling or wall system, behind outlets piercing fire rated membranes.
- .3 Size air outlets as indicated on drawings.
- .4 Refer to air outlet schedule for requirements.

1. GENERAL

1.1 Work Included

- .1 Electric heating coils.
- .2 Accessories.

1.2 Alternatives

- .1 Number of stages, air pressure drops, and such features as clean ability, same or opposite end connections, support etc. approved alternative coils must be the same as type specified.

1.3 Quality Assurance

- .1 Coils shall be the product of manufacturer regularly engaged in production of coils who issues complete catalogue data on such products.
- .2 Coils shall be CSA approved and labelled.

1.4 Submittals - Prior to Construction

- .1 Submissions to include certified data on air pressure loss, air velocity, heat transfer, electrical characteristics, sizes, dimensions, weights.
- .2 Confirm all dimensions for coils on site prior to submission of coil shop drawings.

1.5 Acceptable Manufacturers

- .1 Manufacturers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Thermolec, Neptronic.

2. PRODUCTS

2.1 Electric Heating Coils

- .1 Provide SCR controlled, nichrome electric coils. Internal controls shall be prewired. Provide all necessary contactors, relays, sensors, etc.
- .2 Provide a 0-10V input for BMS coil modulation
- .3 Provide High limit.
- .4 Provide all required air proving temperature limits and safety controls.
- .5 Refer to Division 25 for Controls.

3. EXECUTION

3.1 Installation

- .1 Support coil sections on steel channel or double angle frames and secure to casings.
- .2 Arrange galvanized steel casings for bolting to other section, ductwork or unit casings.
- .3 Provide airtight seal between coil and duct or unit cabinets.
- .4 Coordinate necessary power and control connections to coils.
- .5 Ensure coils are removable for service and cleaning.
- .6 Provide Access Doors both upstream and downstream of coils.
- .7 Refer to Division 25 for Controls.

3.2 Performance

- .1 Refer to coil schedule.

1. GENERAL

1.1 Work Included

- .1 Heat Exchangers – Air to Air
- .2 Operating controls.

1.2 Quality Assurance

- .1 Unit and major components shall be a product of a manufacturer regularly engaged in the production of such equipment.
- .2 Equipment shall be factory built and tested and conform to ARI Certified.
- .3 The heat recovery unit shall be UL listed.
- .4 Fans shall conform to AMCA Bulletins regarding construction and testing, and shall bear the AMCA certified rating seal.

1.3 Acceptable Manufacturers

- .1 Manufacturers of air handling units whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Renew Aire, Losnay, Venmar.

1.4 Submittals - Prior to Construction

- .1 Shop drawings must be submitted and reviewed by the Departmental Representative prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.
- .2 Submit certified shop drawings for the following:
 - .1 Fan curves and sound data.
 - .2 Core efficiency and air delivery performance data.
 - .3 Core materials, pressure drop, accessories.
 - .4 Vibration isolation details.
 - .5 Filter frame and media details, dimensions and efficiency.
 - .6 Cabinet construction, gauge, access doors, fasteners.
 - .7 Dimensions and weights.
 - .8 Power wiring diagrams and electrical characteristics.
 - .9 Control wiring diagrams and interfacing details.
 - .10 Maintenance requirements.
 - .11 Installation and hoisting instructions.

1.5 Alternatives

- .1 Size, test efficiency, initial and final resistance of alternate manufacturer's filters shall be the same as the type specified.
- .2 Requests for approval as an alternative manufacturer must be accompanied by a scale drawing of the proposed equipment in the space available, fan performance, power and sound data, in the form of fan curves (tabulated data will not be accepted), core arrangement and performance, full physical characteristics including weight, sizes, construction details etc.

2. PRODUCTS

2.1 Type

- .1 Unitary design suitable for low pressure operation in configurations shown on the drawings.
- .2 Defrost operation shall consist of a dampered bypass and shall not result in an imbalance between outside air and exhaust air.
- .3 Self-contained, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, controls, air filter.

2.2 Construction

- .1 Cabinet shall be heavy gauge steel with galvanized or baked enamel finish, easily removed access doors or panels with quick fasteners, reinforced where required.

2.3 Fans

- .1 Fans shall be forward curved type with multiblade wheel statically and dynamically balanced.
- .2 Supply and return fans shall be spring isolated.
- .3 Provide all necessary specialized tools and equipment required to perform speed adjustments on ECM, PSC or other motor types.

2.4 Filters

- .1 Media: Washable fiber.
- .2 Arrangement: Flat or angle filter section to limit filter velocity. Provide access doors.

2.5 Core

- .1 Aluminum cross flow design, minimum 65% efficient in heating mode.

3. EXECUTION

3.1 General

- .1 Install units as per manufacturer's recommendation.
- .2 Provide proper adaptors, piping, duct connections, and control interfacing.

3.2 Filters

- .1 Provide Maintenance Information Schedule: all filters provided, with complete information for each air handling unit, listing filter type, specification, model number, thickness, dimensions, etc., suitable for inclusion in maintenance manuals. Refer to Section 23 01 00, Documentation, Manuals and Record Drawings.
- .2 Construct and install filters to prevent passage of unfiltered air. Provide felt, rubber or neoprene gaskets.
- .3 Do not operate fan systems connected to filter banks until filters, temporary or permanent, are in place. Replace filters used during construction.
- .4 Replace filters at Substantial Completion.
- .5 Supply 100% spare refills at Substantial Completion.

3.3 Washing

- .1 Provide services and materials to thoroughly clean the existing heat recovery unit entirely, from the outdoor air, return air mixing chamber, to the discharge of the fan chamber.
- .2 Mixed Air Chamber: Pressure spray wash with detergent. Vacuum clean all surfaces and components. Replace filter media.

- .3 Filter Chamber: Pressure spray wash with detergent. Vacuum clean all surfaces and components. Replace filter media. Replace filter frame gasket and seal material.
- .4 Fan Chamber: Apply degreasing chemical to all fan components including inside the scroll, fan blades, fan side plates, fan shaft, supports and accessories. Pressure spray wash with detergent. Vacuum clean all surfaces and components.

3.4 Performance

- .1 Refer to schedules and drawings for configuration and performance.

1. GENERAL

1.1 Work Included

- .1 Outdoor Evaporator/Condensing Units
- .2 Indoor Fan Coil Units
- .3 Refrigerant Piping
- .4 Refrigeration Specialties
- .5 Controls

1.2 Quality Assurance

- .1 Meet the requirements of CSA, CGA Provincial and Municipal Codes and be CSA listed.
- .2 Comply with standard CAN/CSA C746-93 Performance Standard for Rating Large Air Conditioners and Heat Pumps. Submit certification letter or other confirmation with shop drawings.
- .3 Test and rate cooling system to ARI Standard 210.
- .4 Fans shall confirm to AMCA Bulletins regarding construction and testing.
- .5 Filter media shall be UL listed.
- .6 Comply with applicable codes, laws and regulations. Conform to CSA - B52, Code for Mechanical Refrigeration; and CSA-B31.5, Code for Refrigeration Piping.
- .7 Technicians shall be certified under Ministry of Environment regulations for working with and handling CFC and CFHC refrigerants.
- .8 Polyphase, squirrel cage, single speed NEMA/EEMAC Design A or B induction motors, between 746 watts (1 hp) and 149.2 kw (200 hp), whether in packaged equipment or not, shall comply with the current requirements of the British Columbia Energy Efficiency Standards Regulation, and specifically, CSA C390-93 Energy Efficiency Test Methods for Three Phase Induction Motors.

1.3 Submittals - Prior to Construction

- .1 Shop drawings must be submitted and reviewed by the Departmental Representative prior to the contractor ordering or shipping any subject equipment. Payments will not be processed for equipment not properly documented and reviewed under the terms of submittal.
- .2 Submit certified shop drawings for the following:
 - .1 Heating, cooling and air delivery performance data.
 - .2 Fan performance curves and sound data.
 - .3 Fan details, isolation and details.
 - .4 Filter frame and media details, dimensions and efficiency.
 - .5 Coil materials, pressure drop, accessories.
 - .6 Compressor details, isolation and accessories.
 - .7 Refrigeration specialties and accessories.
 - .8 Cabinet construction, gauge, access doors, fasteners.
 - .9 Condenser guards.
 - .10 Dimensions and weights.
 - .11 Power wiring diagrams and electrical characteristics.
 - .12 Control wiring diagrams and interfacing details.
 - .13 Maintenance requirements.

- .14 Installation instructions.
- .15 Field piping layout drawings with pipe sizes, refrigerant flows, pressure drops in solenoid valves, driers, shutoff hand valves, pipe and fittings on liquid lines, and pressure drop or change in saturation temperature of suction lines. Shop drawings shall be endorsed by equipment manufacturer.
- .16 Ministry of Environment qualification and registration number for technicians working with and handling CFC and CFHC refrigerants.

1.4 Alternatives

- .1 Requests for approval as an alternative manufacturer must be accompanied by a scale drawing of the proposed equipment in the space available, fan performance, power and sound data, in the form of fan curves (tabulated data will not be accepted), coil arrangement and performance, full physical characteristics including weight, sizes, construction details etc.
- .2 Size, NBS test efficiency, initial and final resistance of alternate manufacturer's filters, shall be same as types specified.
- .3 Number of tube rows, air pressure drops and such features as clean ability, drain ability, same or opposite end connections, support and venting of alternative manufacturer, shall be same as type specified.

1.5 Acceptable Manufacturers

- .1 Manufacturers whose products are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Mitsubishi, Daikin.

1.6 Warranty

- .1 Provide five year warranty on compressor.

2. MATERIALS

2.1 General

- .1 Provide lockable weatherproof disconnect switches on outdoor units.

2.2 Refrigerant Piping and Accessories

- .1 Piping shall pre charged flexible piping kits, supplied by the manufacturer, configured in accordance with ASME and provincial government standards.
- .2 Shutoff valve shall be refrigeration grade; angle, globe or ball type.
- .3 Provide valved refrigerant charging connection on liquid line from receiver.
- .4 Provide service valves on suction and discharge of compressors.
- .5 Provide pressure gauge taps where required.
- .6 Provide combination filter/drier sized for full capacity of system. Drier shall have replaceable cores.
- .7 Provide combination moisture and liquid indicator located in the liquid line. Indicators shall be full line size, double lens type, and have seal caps.
- .8 Silver brazed joints using copper phosphorous alloy, with melting point between 1100°F and 1500°F, using current quality control procedures.

2.3 Indoor Unit

- .1 Self - contained, factory assembled and pre-wired, consisting of cabinet and frame, supply fan, coil, controls, air filter and holding frame.
- .2 Cabinet: Heavy gauge steel or plastic easily removed access doors or panels with quick fasteners, reinforced where required. Insulate units with 25 mm thick neoprene coated fibrous glass acoustic insulation.
- .3 Fan: Multi-speed direct drive, centrifugal, forward curved, statically and dynamically balanced.
- .4 Provide all necessary specialized tools and equipment required to perform speed adjustments on ECM, PSC or other motor types.
- .5 ARI certified coils of seamless copper tubing, force fitted to aluminum fins. Enclose coils in coil section with headers and U - bends fully contained within the casing
- .6 Drain pan. Heavy gauge galvanized steel drip pan and drain connection for each coil section, extending 75 mm from face of coil leaving side.
- .7 Provide factory supplied disconnect switch. The disconnect switch shall be in approved case mounted externally on the unit or in such a manner that access can be gained by quick release fasteners or hinged access panels. No other electrical conductors or control devices shall be exposed when gaining access to the main disconnects.
- .8 Provide thermostat for use with IO System. A DDC sensor will be provided for room temperature feed back to the DDC.

2.4 Outdoor Unit

- .1 Self - contained, factory assembled and pre-wired, consisting of cabinet and frame, fan, coil, controls.
- .2 Cabinet: Heavy gauge steel with baked enamel finish, easily removed access doors or panels with quick fasteners, reinforced where required.
- .3 Fan: Direct drive axial fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.
- .4 ARI certified coils of seamless copper tubing, force fitted to aluminum fins. Enclose coils in coil section with headers and U - bends fully contained within the casing.
- .5 Drain pan. Heavy gauge galvanized steel drip pan and drain connection.
- .6 Provide factory supplied disconnect switch. The disconnect switch shall be in approved case mounted externally on the unit or in such a manner that access can be gained by quick release fasteners or hinged access panels. No other electrical conductors or control devices shall be exposed when gaining access to the main disconnects.

2.5 Refrigerant Compressor

- .1 Hermetic compressor, 3,600 rpm maximum with the following accessories:
 - .1 Spring mounted
 - .2 High and low pressure safety controls
 - .3 Motor overload protection
 - .4 Crankcase heater
 - .5 Service valves
 - .6 Filter dryer
- .2 Solid state time out system to prevent rapid compressor cycling.
- .3 Low ambient kit to allow compressor operation to minus 25 degrees Celsius in heating mode and plus 5 degrees Celsius in cooling mode.
- .4 Capable of simultaneous heating and electric heat defrost operation.

2.6 Insulation

- .1 Insulate refrigeration lines throughout. At hanger locations, provide 150 mm long curved metal plate to protect insulation.
- .2 Refer to Section 23 07 13, Piping and Equipment Insulation.

2.7 Controls

- .1 Provide necessary refrigeration controls as specified or required, including relays and control devices.
- .2 Provide for proper operation of safety controls and automatic controls provided under this Division.
- .3 Microprocessor remote panel control panel, hard wired into system:
 - .1 Liquid crystal display screen
 - .2 24 hour on-off timer
 - .3 Heating cooling set point control
 - .4 Fan speed control
 - .5 Space and air flow temperature display
 - .6 Each fan coil to be provided with IO Interface for DDC integration with the following points
 - .1 On Off (Digital Input)
 - .2 Set Point (0-10V Analog Input)
 - .3 Mode of Operation (0-10V Analog Input)
 - .4 Fan Speed (0-10V Analog Input)
 - .7 Status Outputs
 - .1 Error Digital Output
 - .2 Compressor ON/OFF
 - .3 Mode of Operation (Heating or Cooling)

2.8 Outdoor Unit Coil Protection Guards

- .1 Steel frame of 20 mm square, hollow structural steel tube, welded construction, 20 gauge expanded metal mesh, 15 mm openings maximum, welded to frame.
- .2 Frames to be drilled and bolted to rooftop unit frame to entirely cover all condensing coils. Each frame to be secured with no less than 6 sheet metal screws.
- .3 Provide multiple sections if necessary.

2.9 Outdoor Unit Bases

- .1 Provide roof pans and galvanized steel channel to install condensing unit / heat pump 300mm above the house keeping pad.

3. EXECUTION

3.1 Refrigerant Piping

- .1 Size piping for minimum pressure drop in system. Pipe sizing shall be in accordance with manufacturer's requirements.
- .2 Arrange piping runs and equipment locations to comply with manufacturer's maximum elevation difference and piping length between outdoor and indoor unit.
- .3 Arrange piping to return oil to compressor. Provide traps in piping systems if required. Keep horizontal dimensions of traps as small as possible.

- .4 Attach hangers and supports as required. Provide one hanger 500 mm minimum from each change of direction.
- .5 Arrange piping loops in suction lines to prevent liquid refrigerant from draining into compressor during shutdown.
- .6 Provide flexible connections where required.

3.2 Indoor Units

- .1 Suspend units from structure. Utilizing vibration isolation hangers.
- .2 Provide flexible duct connections.
- .3 Pipe condensate to drain.

3.3 Outdoor Units

- .1 Mount units on housekeeping pad on structural base as noted on drawings.
- .2 Secure outdoor unit to base with hold down lag screws or bolts. Adjust lock nuts to maintain clearance required by neoprene pads and mounting base.
- .3 Position condensing unit no closer than 1.8 metres from gas vent discharge.

3.4 Testing, Dehydration, Charging and Start-Up

- .1 At completion of the installation, pressurize system and check for refrigerant leaks. Repair leaks and retest. Dehydrate system and charge with refrigerant. Start up system, and check out operation.
- .2 Utilize services of certified refrigeration technicians for start - up. Include completed and signed check lists in operating and maintenance manuals.
- .3 If installation is completed in winter season, pump down refrigerant and repeat procedure at start of next cooling season.
- .4 Provide manufactures start up and test documentation.

3.5 Outdoor Unit Coil Protection Guards

- .1 Provide guard screens on all new outdoor units.
- .2 Confirm dimensions and required quantity by site survey.

3.6 Performance

- .1 Refer to outdoor unit schedule.
- .2 Refer to indoor unit schedule.

1. GENERAL

1.1 Work Included

- .1 Electronic and electric control system for mechanical systems.
- .2 Control devices, components, wiring and material.
- .3 Automatic control valves.
- .4 All relays, devices, components, wiring, conduit, etc., for line or low voltage interlocking.
- .5 Operators for new dampers and valves.
- .6 Software and programming for new and existing systems.
- .7 Wiring and testing of equipment control panels not factory mounted and wired.
- .8 Modifications and renovations to existing systems.
- .9 Check out and commissioning of new and existing control systems.
- .10 Training and instructions to Departmental Representative for new and existing systems.
- .11 Remove all existing wiring, material and equipment not being reused. Do not abandon in place.

1.2 Quality Assurance

- .1 Work specified in this Section shall be done by qualified technicians, experienced and skilled in the tasks of installing and checking out the components, wiring and systems installed.
- .2 Adhere to all applicable electrical codes and regulations.
- .3 Obtain electrical permit.
- .4 For non-CSA equipment, submit to Inspection Authorities and obtain approval prior to installation of equipment on site.

1.3 Submittals - Prior to Construction

- .1 No work on control systems is authorized, nor will progress payments be considered until all control systems submissions have been provided and accepted.
- .2 For the systems and components provided under this Division, provide complete documentation including but not limited to wiring diagrams, installation and maintenance instructions, verification and check-out procedures, performance range, voltage and current characteristics, etc.
- .3 Provide fully integrated diagrams and shop drawings for all systems and components, including those supplied under other Sections or Divisions of the specification.
- .4 Controller and panel shop drawings are to include the model number of the control chips and other components included in the equipment.
- .5 Controller configuration, positioning and location to be coordinated and confirmed with Departmental Representatives prior to installation. Provide plan showing all main panels, controllers and controls cabinet locations to Departmental Representative for approval.
- .6 Provide full schematic drawing of mechanical systems with all control points and devices clearly marked and labelled. The Departmental Representative will provide electronic copies of mechanical systems schematic for this purpose.
- .7 Provide full list of all points and control systems devices, reconciled with the points list included in the specification.
- .8 Provide written Sequence of Operation for every system under the scope of this Contract. The sequence must be written with wording differing from the Sequence of Operations below, but with the same intent.
- .9 Provide pre-commissioning report on all existing control points. Identify all problems that were discovered, including at least one recommended solution with costs.

1.4 Submittals - Prior to Substantial Performance

- .1 Provide trend logs demonstrating that the boiler systems operate smoothly. Coordinate with the boiler manufacturer's start up technician and provide assistance as required to complete the start up to the satisfaction of the Departmental Representative.
- .2 Once the systems has been commissioned and all components are operational, provide trend logs for all systems.
- .3 Provide hand written "end to end" checks of all control points.
- .4 Provide post construct "record" shop drawings for inclusion in maintenance manual. Include handwritten end to end checks for all points.

1.5 General

- .1 The scope of the work specified in this Division includes but is not limited to:
 - .1 All sensors, actuators, relays, contactors, power supplies, conduit, wiring, tubing, and other field devices, control valves etc.
 - .2 All required wiring and conduit from field input/output devices, to the BAS panel terminal strip and the control modules locations and termination of same.
 - .3 All required 120 volt AC wiring and connections for control systems, operators and components.
 - .4 Wiring from all control modules back to the BAS panel terminal strip.
 - .5 Supply, installation and mounting of all controls equipment and components.
 - .6 Verification, calibration and continuity checks of all wiring and components installed by this Division.
 - .7 Request and witness tests, for installation certification conducted by the Departmental Representative on each sensor and actuator point installed.
 - .8 Comply with all the requirements stated elsewhere in the specification for shop drawings, approvals, documentation and record drawings. This requirement applies specifically to physical location layout drawings and detail drawings.
 - .9 Coordinate the location and mount the supplied metal enclosure. Connect all conduit, and terminate all wiring to a removable termination strip. Provide wiring, tagging, and panel point layout sheets on inside panel door.
 - .10 Standardized tagging to be used to identify all points on project.

1.6 Coordination Division of Responsibility

- .1 Provide coordination services between the Departmental Representatives, Commissioning Authority, the Contractor, the Specialty Engineer, the Commissioning Agent, and others as necessary.
- .2 Cooperate and attend as required to complete the installation and commissioning procedures as specified in this Section and in other Sections of the Specification.
- .3 Cooperate and assist the Commissioning Agent in the verification and commissioning of all systems and components.

1.7 Verification and Acceptance

- .1 Refer to Section 23 05 93.3 Commissioning.
- .2 Complete all pre-testing and verification of points, and systems installed under this Section using qualified and experienced personnel.

1.8 Description of Control System

- .1 System display and interface to be full colour graphics type.
- .2 The HVAC system is defined by a points list which identifies each input or output. Review the point sheet which identifies panel numbers, point description, input output number, field device and wiring detail reference, etc.
- .3 For specific definition of each sensor and actuator, its installation and connection to SAP, the contractor shall refer to the detailed point sheets included, and wiring details for that device.
- .4 Point sheets identify each specific device, sensor or operator and certain connection details or requirements.
- .5 When the project is completed this documentation is to be updated by these contractors to record drawing condition.

1.9 Definitions and Abbreviations

- .1 The following are abbreviations used throughout the section defining computerized control systems specified herein or defined on plans.
 - .1 DDC Direct Digital Control
 - .2 BAS Building Automation System
 - .3 SAP Stand Alone Panel
 - .4 DI Digital Input
 - .5 DO Digital Output
 - .6 AI Analog Input
 - .7 AO Analog Output
 - .8 HVAC Heating, Ventilating, Air Conditioning
 - .9 MCC Motor Control Centre
 - .10 R Relay
 - .11 WTS Water Temperature Sensor
 - .12 RTS Room Temperature Sensor
 - .13 DTS Duct Temperature Sensor
 - .14 SAT Supply Air Temperature Sensor
 - .15 MAT Mixed Air Temperature Sensor
 - .16 RAT Return Air Temperature Sensor
 - .17 OAT Outdoor Air Temperature Sensor
 - .18 CT Current Transformer
 - .19 OPR Damper or Valve Operator
 - .20 DMP Damper Operator

1.10 Software and Documentation

- .1 Software: Update the existing software with new control points and graphics as required for the new systems.
- .2 During the first year warranty period, the controls system supplier shall maintain duplicate software back-up copies of the most current software and programs. The control system supplier shall be capable of uploading the back-up programs by, at the request of the Departmental Representative.
- .3 Provide fully operational and unrestricted copies of HVAC control system software and documentation to the Departmental Representative, for the unconditional operational and maintenance use by the building operator.

- .4 Provide copies of the software and documentation to the Departmental Representative for use by the building operator to monitor the system.
- .5 Provide training, documentation and software necessary to allow the Departmental Representative to access the control system through the Departmental Representative owned personal computers.

1.11 Alternative Components

- .1 Submission for alternative components will be reviewed by the Departmental Representative, subject to the following:
 - .1 Complete and acceptable submissions for alternates must be received ten days prior to the closing of sub trade tenders.
 - .2 Submissions must include precise and complete detail for wiring, electrical ratings, and accessory requirements.

1.12 Maintenance Data and Service

- .1 Refer to Section 23 05 00 Documentation, Manuals and Record Drawings.
- .2 Provide for complete service of controls systems, including call backs, for one year running concurrent with guarantee.
- .3 Verify system operation throughout the one year maintenance period to ensure stable and acceptable operation in all operating conditions.

1.13 Guarantee

- .1 Provide a written guarantee, signed and issued in the name of the building operator stating that the controls system, materials, devices and software are guaranteed against faulty material and workmanship for a period of one year from the date of Substantial Performance.

1.14 Trade Co-operation

- .1 The control subcontractor shall oversee the operation, installation and adjustment of all devices and components that are directly or indirectly controlled or affected by the systems installed under this Division.
- .2 Provide wiring diagrams, instructions, supervision, and attendance services to other trades as necessary to complete the installation, testing and adjustment of the systems installed under this Division.

1.15 Acceptable Manufacturers

- .1 Control system contractors that are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Johnson Controls
- .2 Valve, valve actuator and damper actuator manufacturers that are approved in principle, but subject to requirements of drawings and specifications are:
 - .1 Belimo

2. PRODUCTS

2.1 Field Devices

- .1 All sensors and controllers shall be of commercial grade. Provide full details of all sensors and controllers proposed, including their range and accuracy.
- .2 The sensors shall conform to the following table:

Description	Accuracy	Range
Duct air temperature	+/- 0.2 degrees C	0 to 40 degrees C
Space temperature	+/- 0.2 degrees C	0 to 50 degrees C
Outside air temperature	+/- 0.2 degrees C	-40 to 40 degrees C
Water temperature	+/- 0.2 degrees	0 to 120 degrees C
Current sensors		+/- 2% of full scale

- .3 Provide data on accuracy, range, output signal characteristics, repeatability, linearity, dead band as applicable. Include data on hysteresis and defined curve/calibration points for any products for pre-tender approval as an equal to those specified.
- .4 Due to limitations, which alternate sensors impose on the software system, i.e. ranging etc. the number of alternates has been limited in each sensor/device category. All field devices shall be as indicated, with manufacturer and model numbers noted.
 - .1 Duct temperature sensors
 - .1 Greystone TE 200 B 7E2
 - .2 Delta DTS 410
 - .2 Room temperature sensors
 - .1 Greystone TE200 AE7
 - .2 RTS 401-1
 - .3 Hot water sensors
 - .1 Greystone TE 200 C7B2
 - .2 Delta WTR 420
 - .4 Current transducers
 - .1 Delta CUR 450
 - .2 Greystone C 5150
 - .5 Freeze stat
 - .1 Ranco 016-264
 - .2 Johnson Controls A70HA1
 - .6 Solid state relays
 - .1 Grayhill 70S2-04-6-12-S
 - .2 Electromatic RS 104240-10-0
 - .3 Wespac KS210
 - .4 Potter & Brumfield EOTZ series
 - .7 Status relay
 - .1 Omron 25D-22423 T-US
 - .8 Large damper operators
 - .1 Belimo AF 24 SR
 - .2 Johnson M130 GGA
 - .9 Large valve operators: modulating (38mm nominal or more)
 - .1 Johnson M130 GGA
 - .10 Small valve operators: non-modulating (less than 38mm)
 - .1 Honeywell V8043A
 - .2 Erie 773B series
 - .11 Small valve operators: modulating non-spring, (38mm nominal or less)
 - .1 Belimo NM 24 SR

2.2 Main Control Panel (Stand Alone Panel)

- .1 Controllers shall be fully free programmable and shall not be limited to predetermined sequences.
- .2 Panel I/O configuration to be 24 universal inputs, capable of accepting 0-5 vdc, 402 ma, thermistor or dry contact signals. 24 universal outputs, type digital or analogue, software selectable. Outputs to source 10 vdc @ 20 ma.
- .3 Panel to incorporate I/O expansion slots to allow expansion in groups of 8 or 16 universal inputs or outputs.
- .4 Panel to have communication ports for a local PC, a LAN port for connection to the building LAN and internet.
- .5 Panel to have visual status indicators on inputs and outputs, user access, CPU operation, and network communication.
- .6 Panel to UL916 Listed and FCC rated Class A.

2.3 Controller

- .1 Controllers shall be fully free programmable and shall not be limited to predetermined sequences.
- .2 Panel I/O configuration to be 11 universal inputs, capable of accepting 0-5 vdc, 4-20 ma, thermistor or dry contact signals. 8 universal outputs, type digital or analog, software selectable. Outputs to source 10 vdc @ 20 ma or 8 digital triac outputs capable of switching 24 vac @ 0 amps maximum.
- .3 Panel to have 2 communication ports for connection to Intelli-Stat sensors, and Intelli-Zone network. Panel may be optionally configured for connection to RS232 network.
- .4 Panel to UL916 Listed and FCC rated Class A.

2.4 Temperature Sensors – General

- .1 Sensors shall be thermistor or RTD type with a high resistance versus temperature change to ensure good resolution and accuracy.
- .2 Sensors to be compatible with input requirements of BAS system.
- .3 The sensor shall give an end to end accuracy of not less than $\pm 0.2^{\circ}\text{C}$.
- .4 The sensor shall connect to the controller by means of a two wire cable.

2.5 Temperature Sensors – Space

- .1 Electronic wall mounted sensors compatible with controllers and input requirements for BAS system.
- .2 Sensors to be tamper proof where specified. Refer to the points list
- .3 If identified on points lists, sensors shall be complete with 4 programmable buttons on the faceplate that can be programmed for auxiliary control.

2.6 Temperature Sensors - Air Stream

- .1 Electronic duct mounted sensors with remote sensing elements as required, and to be compatible with input requirements for BAS systems.
- .2 Plenum sensors to be averaging type.

2.7 Temperature Sensors – Pipe

- .1 Electronic pipe immersion well sensors with remote sensing elements as required, and to be compatible with input requirements for BAS systems.
- .2 Conductor length to be suitable for application.
- .3 Provide compatible brass immersion well, 19 mm NPT.

2.8 Low Limit Temperature Sensors – Coil Protection

- .1 Vapour tension element. Operation temperature range from –60°C to 10°C.
- .2 Threaded fittings for mating to 12 mm conduit.
- .3 Capable of providing input to the control system.

2.9 Motor Current Sensors

- .1 Sensors shall vary or interrupt voltage with sensing motor current draw.
- .2 Provide analogue or digital as identified on points list.

2.10 Operators – Dampers

- .1 Electronic gear driven modulating damper operators with spring return to "fail-safe" in normally open or normally closed position as required.
- .2 Full range modulating operators to be compatible with torque and mounting requirements of air stream dampers or air handling units.
- .3 The actuator drive speed shall be variable and the actuator travel shall be continuously adjustable to prevent damage due to over torqueing. It shall be possible to recalibrate the damper actuator for clockwise or counter-clockwise damper operation.
- .4 The operator shall be capable of reporting the position of the damper using end switch feedback.
- .5 Refer to Section 23 33 00 Air Duct Accessories for dampers.

2.11 Operators – Valves

- .1 Electronic gear driven operator.

Heating coil coil	modulating	spring return
Unit heater heating coil	two position	spring return
- .2 Full range modulating operators to be compatible with torque and mounting requirements of controlled valve.
- .3 Provide analogue or digital as identified on points list.
- .4 Valves shall "fail-safe" spring return to normal position.

2.12 Valves Automatic - Three Way

- .1 Provide valves in accordance with general valve specification. Provide position indicators on valves and pilot positioner on sequenced valves.
- .2 Ball Valve: Forged bronze body, delrin seat and seals, chrome plated ball, forged steel pin, screwed ends, 1,200 kPa (175 psig) WOG.
 - .1 Up to 38 mm: use mixing valve or diverter valve.
 - .2 50 mm and over: use globe body valve.
- .3 Ball valves used for modulating services shall be characterized type.
- .4 Valves shall "fail-safe" spring return to normal position.
- .5 Provide Combination Tappings for Instrumentation on each piping connection. Refer to Division 23
- .6 Submit valve Cv rating in all configurations.

2.13 Transformers

- .1 Transformers required for DDC Panels shall be 120 volt/24 volt, 50 or 100 volt amp capacity and shall contain an integral circuit breaker. Provide mounting box to accommodate transformer, accessories, etc.

2.14 Wiring and Methods

- .1 Conduit general: EMT conduit, Steel fittings.
- .2 Conduit flexible; liquid tight, coated flexible, maximum length 500 mm, cast or liquid tight fittings. Application only from junction box and EMT conduit to equipment requiring flexible connection for vibration isolation or service access.
- .3 Conductor:
 - .1 Line voltage power or switched power wiring - No. 12 gauge copper wire minimum.
Line voltage control wiring - No. 14 gauge copper wire, length not to exceed 50 metres, No. 12 gauge copper wire, lengths exceeding 50 metres.
Low voltage No. 18 gauge, twisted, stranded wire as directed by applicable electrical codes and requirements. Shielded cable where required or specified.
Low voltage No. 22 gauge, twisted stranded pair. Shielded cable where required or specified.
MSTP Network Cable shall be no. 24 twisted, shielded, stranded, low capacitance cable.
- .4 Device and Wiring Boxes
 - .1 Heavy gauge aluminum or steel, front access hinged cover, screwed fastening, no gasket unless required by installation environment.
 - .2 Comply with BC Electrical Code and all other applicable codes. Rating suitable for installation environment.
 - .3 Provide inside separation walls and dividers to separate low voltage wiring from line voltage wiring.
 - .4 Size as required, minimum as shown on detail sheets.
 - .5 Provide FS style boxes in Public areas.

2.15 Device and Wiring Boxes

- .1 Heavy gauge aluminum or steel, front access hinged cover, screwed fastening, no gasket unless required by installation environment.
- .2 Comply with BC Electrical Code and all other applicable codes. Rating suitable for installation environment.
- .3 Provide inside separation walls and dividers to separate low voltage wiring from line voltage wiring.
- .4 Size as required, minimum as shown on detail sheets.

2.16 Control Panels

- .1 Provide heavy gauge, surface mount steel panels with gasketted and hinged access door to house control equipment. Enamelled finish.
- .2 Provide terminal strip connection for external wiring, transformers, override timers, clocks, night setback thermostats etc.
- .3 Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
- .4 Mount panels in equipment room near equipment served, on vibration free walls.

2.17 Identifier Labels and Plates

- .1 All components, cables, wires, devices, valves, and accessories shall be identified by label or tag. The label or tag shall include the device identification, point name, plus a functional description.
- .2 Labels - General: Engraved plastic, two colours, white background with black contrasting letters. Plates shall be minimum 20 mm high, letters shall be minimum 3 mm wide, 12 mm high.

- .3 Labels - Emergency: Engraved plastic, two colours, red background with white contrasting letters. Plates shall be minimum 40 mm high, letters shall be minimum 12 mm wide, 20 mm high.
- .4 Labels - Warning: Engraved plastic, two colours, amber background with black contrasting letters. Plates shall be minimum 40 mm high, letters shall be minimum 12 mm wide, 20 mm high.
- .5 Tagging - Conductors: Thomas & Betts E-Z-Coder wire marking system, or heat shrink label, or equivalent system.
- .6 Provide labels for the following systems:
 - .1 Standard: All control panels and devices: Refer to Part One of this Section and Section 23 05 00 Common Work Results for HVAC.

3. EXECUTION

3.1 General

- .1 Check and verify location of sensors and thermostats and other control devices with plans and room details before installation.
- .2 Supply approved accurate and complete shop drawings and wiring diagrams to complete the installation.
- .3 Do not install top entry wiring connections to control panel enclosures where there is a risk of sprinkler operation of other source of water ingress.
- .4 Provide minimum 2m of spare wire in control enclosures for each point.
- .5 Ensure that the wiring and device location, installation and labelling, is correct, and operation is in compliance with specifications. Submit a written report.
- .6 The installation shall conform both to manufacturer's recommended procedures, and all applicable codes and regulations, and to the approval of authorities having jurisdiction.
- .7 All equipment installed shall be mechanically stable and as necessary, fixed to wall or floor. Anti-vibration mounts to be provided, if required, for the proper isolation of the equipment.
- .8 Equipment shall be installed so as to allow for ease of maintenance access. Equipment shall be installed such that it does not interfere in any way with access to adjacent equipment and personnel traffic in the surrounding areas.
- .9 Mount and wire equipment control panels intended to be installed as part of packages or systems specified under this Division.
- .10 Tune controllers to ensure systems do not hunt. Verify system operation throughout the one year maintenance period to ensure stable and acceptable operation in all operating conditions.

3.2 Identification and Labels

- .1 Permanently identify all components, cables, wires, devices, valves, and accessories provided under this Section in accordance with specifications.
- .2 All concealed equipment is to be noted by tagging the appropriate wall or ceiling panel with a colour coded dot.
- .3 All field wiring shall be tagged at both ends.
- .4 Each terminal or termination point shall have a designation unique for each wire.

3.3 Interlocking

- .1 Three phase motor control starters or contactors are specified under other Divisions. This Division will provide interlocking or enabling relays on the 24 volt coils on the starters, or horsepower rated relays on single phase motors. Refer to equipment schedules.
- .2 Interlocking is to be done through the BAS program, not by relay or auxiliary contacts on motor starters.

- .3 Allow for installation and programming of specified number of relays for control of new fans. Connect to appropriate controller or main panel. Refer to points list.

3.4 Installation of Sensors – General

- .1 Sensors shall be rigidly mounted and mountings shall be adequate for the environment within which the sensor operates.
- .2 Supply and install approved temperature wells of the appropriate size and type for sensing water temperatures.
- .3 All temperature, humidity, pressure, and flow sensors shall have their locations pre-approved by the Departmental Representative prior to installation.
- .4 Fasten capillaries with clips to prevent abrasion and damage.
- .5 Provide grommets where capillary penetrates the ductwork.
- .6 Mount all sensing elements where stratification is minimal so accurate air temperature measurement is achieved.
- .7 On air systems sample the duct temperatures to determine the best possible location for the sensors to eliminate stratification effects.
- .8 Select the location to ensure proper space temperature is sensed and building, room and solar effects are minimized.
- .9 All immersion temperature sensors shall have heat conductive compound added to the immersion wells.

3.5 Space Sensors and Thermostats

- .1 Mount 1,500 mm above floor, or at the same level as lighting controls.
- .2 Sensors located on outdoor or cold walls are to be provided with an approved insulating sub-base.
- .3 Conduit and mounting boxes for sensors are to be sealed and plugged with expanding foam spray material to prevent convective air currents in the conduit or wall from affecting the sensor.
- .4 Sensors are not to be located near or above heat producing equipment or fixtures.
- .5 Sensors connected to a control panel by network wiring shall not be connected on the same sub network as any other piece of equipment other than sensors of the same type.

3.6 Low Limit Temperature Sensors – Coil Protection

- .1 The vapour tension element shall be installed in a serpentine pattern across the complete coil face. For large coil areas use two sensors in series. Install on the upstream side of cooling coils and the downstream side of heating coils.

3.7 Wiring

- .1 Flexible conduit with maximum length of 500 mm is allowed only from junction box and EMT conduit to equipment requiring flexible connection for vibration isolation or service access. BX sheathed cable is not approved.
- .2 All control wiring not concealed in walls, shall be run in conduit. This includes mechanical and service rooms, and ceiling spaces. Conduit and wiring shall conform to the standards specified under Division 16.
- .3 Conductors not installed in conduit shall be adequately secured with tie wraps or other approved methods, secured to building structure or walls. Wiring shall not be secured to other systems, conduit, piping or ductwork etc. Routing of exposed cable will be parallel with building lines, provided with 90 degree change of direction, tensioned to prevent sagging, and maintain clearance above ceilings by securement to structure or walls.

- .4 Conduit and wiring accessories are not to be secured or mounted on equipment, except where terminations are to be completed. Circuitry from unit to unit is to be branched from a conductor run positioned remote from the equipment, allowing adjustment or removal of the equipment without the need to disrupt the conduit. Conduit shall not hinder access to, or opening of, access panels or doors and service positions. Flexible conduit shall be used where devices are mounted on doors or other moving components, including spring isolated elements.
- .5 Any exposed conduits or cables shall be run parallel to or at right angles to building lines and in a neat manner.
- .6 Wiring between controller and end devices in gas fired appliances equipped with electronic ignition, shall be shielded type cable. Cable to be 18 gauge, 10 conductor minimum, or more as required for additional components. Shield to be grounded at controller end and isolated at rooftop end.
- .7 The Departmental Representative may reject work, wiring and installations not done in a fashion demonstrating care and workmanship to an acceptable level.
- .8 Provide power circuit, 120 volts, single phase, for any control equipment requiring same. Power circuit to be run with materials and methods in compliance with standards specified under Division 16.
- .9 Lace or clip groups of power or control conductors in panels, pull boxes and termination points.
- .10 All grounding conductors are to be copper. All ground conductors to have green insulation jacket.
- .11 Data cabling verification required at both ends shall be completed by the controls agent.
- .12 The controls agent is responsible for the continuity of all controls wiring, even if the wiring was installed by others.
- .13 All control and power wiring shall conform to the following ratings based on construction type as well as whether or not the ceiling space is used as a return air plenum:
 - .1 Non-combustible construction, plenum ceiling: FT6 rated wiring

3.8 Control Panel Wiring and Installation

- .1 All wiring shall be clearly tagged at terminations.
- .2 All equipment located inside the panel shall be securely fastened to the panel.
- .3 Panels shall be mounted with the clearance and provision for mounting an additional future panel adjacent. Conduit entry into the SAP shall be from the top or bottom to allow for future panel additions on each side.
- .4 Terminate all conductors on the terminal strips supplied with the enclosure.
- .5 For new wiring, provide minimum 2m of spare wire in control enclosures for each point.
- .6 If any wire splicing is required, it shall be completed in new terminal strips.
- .7 All data cabling requires verification at both ends by same party.
- .8 Refer to detail.

3.9 Calibration and Verification

- .1 Refer to Section 23 05 93.3 Commissioning, Section 23 05 00, Documentation, Balancing and Record Drawings.
- .2 For systems and components supplied or installed under this Section, check, adjust and calibrate each device and individual wiring sections, to the satisfaction of the Departmental Representative.
- .3 Every point shall be checked end to end to ensure accuracy and integrity of systems.
- .4 Provide signed and dated reports certifying that all systems have been tested and adjusted to specified or instructed conditions.
- .5 Provide record copies of all set points, tests and adjustments for all devices and schedules.

3.10 Controllers

- .1 Confirm location and positioning of all controllers and panels with Departmental Representative prior to installation. Submit plan.
- .2 Mount devices as required near equipment served.
- .3 Controllers are to be installed in compliance with the specifications and as shown on detail sheets.
- .4 Unless otherwise specified, neither controllers nor any other device is to be mounted on equipment served. Devices are to be mounted on structure, walls or field fabricated brackets near equipment served in such a manner that equipment can be removed for service without dismounting the controller, sensor or device. Only wiring and conduit from the controller to the controlled device need be disconnected.
- .5 Install controllers complete with accessories. Provide 120 volt AC connection, and transformers as required for each controller. Alternating current power source is to be taken from the control panel of equipment served, or from a dedicated 120 volt AC source provided from a local electrical panel.
- .6 This Division is responsible for determining the nature of the requirement, providing necessary breakers and local panel, providing conduit and wire and other accessories from the panel to the point of use. All wiring and accessories to be in compliance with the standards of Division 16.

3.11 Electric Heater

- .1 Provide relays on each indicated heater to control operation.

3.12 Trend Logs

- .1 Once the systems has been commissioned and all components are operational, provide trend logs over a minimum period of two days for all rooms, zones, primary systems, terminal systems and any other systems required to confirm correct BMS operation.
- .2 All points must be trended using a colour display format, complete with legend. Use a multi-trend system to display set points and measured parameters for individual systems on the same page. Trends shall be recombined and resubmitted if the format is deemed to not be acceptable by the Departmental Representative.
- .3 Identify and explain any discrepancies or undesired systems responses.
- .4 Be prepared to alter programming, tune control loops, adjust damper linkages, verify sensor calibration, adjust dead bands etc.
- .5 Coordinate with boiler start-up technician to provide trend logs showing that boilers operate consistently and are able to maintain set points without hunting.
- .6 Repeat the above process until trend logs show that systems operation is acceptable and within tolerances.

3.13 Points List

- .1 Refer to points list at the end of this section in Specification 25 90 05.

1. GENERAL

1.1 Graphics

- .1 Existing graphics shall be updated to include new points and systems.
- .2 Current Sensor Display: Any electric motor required by the points list to display running amps, shall also have on the display, whether graphics or screen text, the rated full load amps of the motor.
- .3 All set points, valves and measurements listed in the control sequences must be user adjustable from the graphical user interface.

1.1 Breakout Price #1 Item 5.4 Bus Passenger Processing Area HVAC Control Upgrade

- .1 The existing system consists of a common outside air plenum for existing heat pumps HP-1, HP-2 and HP-3.
- .2 Each heat pump is provided with a custom built economizer. Outside air is drawn into each heat pump using the mixed air dampers.
- .3 The Bus Passenger Processing Area is currently set to run on a schedule for 5am to 10pm daily. This schedule shall be disabled.
- .4 The new occupancy sensor shall be used to determine occupancy.
- .5 During occupied mode, the programming shall remain as is.
- .6 During unoccupied modes, the mixed air dampers shall close to 100% recirculation. The space temperature set point shall be maintained at 18 deg. C (adjustable) in heating and 25 deg. C (adjustable) in cooling.

1.2 Breakout Price #1 Item 5.5 Public Washroom Control Upgrade

- .1 The existing system consists of a furnace F-3 and exhaust fan EF-20. The furnace acts as a make up air unit for exhaust fan EF-20 and provides heating and cooling to the washrooms.
- .2 Two new occupancy sensors will be installed and used to control F-3 and EF-20. One sensor in Men's NO102 and one sensor in Women's NO103.
- .3 If either occupancy sensor detects occupancy, EF-20 and F-3 shall run as per original programming. The fans will continue to run while the space is occupied and for 30 minutes (adjustable) after the space changes to unoccupied.
- .4 When the space is unoccupied, the space temperature set points shall be maintained at 18 deg. C (adjustable) in heating and 25 deg. C (adjustable) in cooling.

1.3 Breakout Price #1 Item 5.7 PIL Booths Standby Ventilation Energy

- .1 The existing system consists of a common outside air plenum for existing heat pumps HP-1, HP-2 and HP-3.
- .2 Each heat pump is provided with a custom-built economizer. Outside air is drawn into each heat pump using the mixed air dampers.
- .3 HP-2 is used to ventilate the PIL booths with 100% outside air. During heating, ventilation air tempered using the heat pump as 1st stage and subsequent stages 2 to 6 by the electric duct heater EHD-2.
- .4 During heating, the existing duct heater is used to control the preheat temperature to 15 deg. C and the heat pump heats the air.
- .5 A second duct heater was provided to trim heat in the space.
- .6 Space conditioning of the PIL Booths is provided by an air source heat pump.
- .7 The existing system creates temperature swings during both heating and cooling.
- .8 Existing programing will remain the same with the following changes.

- .9 HP-2 will function only if one of the four PIL occupancy sensors detects occupancy.
- .10 During unoccupied mode, space temperature will be maintained at 18 deg. C (adjustable) in heating and 25 deg. C (adjustable) in cooling. The existing air source heat pump will maintain these conditions.
- .11 During occupied mode, space temperature will be maintained at 21 deg. C (adjustable) in heating and 24 deg. C (adjustable) in cooling. The existing air source heat pump will maintain these conditions when any one of the four PIL occupancy sensors detects occupancy, space temperature will be maintained by the air source heat pump and HP-2 will be used to provide ventilation air and pressurization.
- .12 It should be noted that temperature swings during cooling mode are expected.
- .13 The existing electric duct heater EDH-2 will be replaced with a fully modulating duct heater with SCR control.
- .14 On a call for ventilation/pressurization from one of the four PIL Booth occupancy sensors the system will be sequenced as follows for heating:
 - .1 HP-2 Supply fan will start.
 - .2 The supply air temperature sensor will monitor supply air from HP-2.
 - .3 HP-2 minimum entering air temperature is 11.7 deg. C. The lift that HP-2 will provides will cause the supply air temperature to be above the heating set point. Essentially in heating this eliminates the use of HP-2 to temper the air.
- .15 If outside air temperature is less than 18 deg. C, EDH-2 will be used to temper ventilation and pressurization air to the PIL Booths.
- .16 The supply air temperature sensor will be used to modulate the EDH-2 SCR controller to meet the set point of 20 deg. C.
- .17 If the outside air temperature is between 18 deg. C and 26 deg. C, the supply air from HP-2 will not be tempered. Both EDH-2 and the HP-2 compressor shall be off.
- .18 If the outside air temperature is above 26C, the heat pump will be switched to cooling and the compressor will run.
- .19 The existing duct heaters in the PIL Booths (EDH-6, 7, 8 and 9) will remain but will not be used unless the existing heat pump space temperature cannot be maintained by the air source heat pump.
- .20 The maximum air temperature for HP-2 is 30 deg. C. If the outside air temperature is above 30 deg. C, HP-2 will be shut off and the PIL Booths ventilation cooling load will be addressed using the air source heat pumps. Space temperature may become uncomfortable on warm days.

1.4 Breakout Price #1 Item 5.9 Reduce Admin. Building Ventilation

- .1 The existing system consists of a common outside air plenum for existing heat pumps HP-22, HP-23, HP-25, HP-26, HP-27, HP-28, HP-29 and HP-30.
- .2 Each heat pump is provided with a custom built economizer. Outside air is drawn into each heat pump using the mixed air dampers. Only HP-22, HP-23, HP-26, HP-27, HP-29 economizer control will be affected.
- .3 The building contains a common relief air system. Relief air flows back to Mechanical Room NA217. As the economizers open, air is relieved through the relief air louvre in NA217. This system has been disabled.
- .4 Existing controls sequence shall remain as is with the following changes.
- .5 For Item 5.9, a user adjustable Occupancy Schedule shall be implemented as noted:

TAG	DESCRIPTION	HOURS OF OPERATION	MODE
HP22	Admin 2 nd Floor Chief Office	M-F 8am to 4pm	Occupied
		All other hours	Unoccupied
HP23	Admin 2 nd Floor Offices	M-F 8am to 4pm	Occupied
		All other hours	Unoccupied
HP26	Admin 1 st Floor Immigration	M-F 8am to 9pm	Occupied Demand Controlled Ventilation
		All other hours	Occupied Demand Controlled Ventilation
HP-27	Admin 1 st Floor	M-F 8am to 9pm	Occupied Demand Controlled Ventilation
		All other hours	Occupied Demand Controlled Ventilation
HP-29	Admin 2 nd Floor Food Inspection and conference room	M-F 8am to 4pm	Occupied Full Ventilation
		All other hours	Unoccupied

- .6 The occupied mode will be defined as per existing control sequence. Minimum outside air values will remain unchanged, economizer controls will remain unchanged unless overridden as noted above.
- .7 During occupied demand controlled ventilation mode, mixed air dampers shall be adjusted maintain CO2 levels at or below 1100ppm. The DDC system will monitor all CO2 sensors for spaces served by a common heat pump. The space with the highest CO2 reading shall be used to control the mixed air dampers. (Applicable to HP-26 and HP-27 refer to points list.
- .8 During unoccupied mode, each economizer will be closed to 100% recirculation air. Fans will only cycle on a call for heating or cooling. The unoccupied temperature will be controlled to maintain the space between 19 deg. C and 20 deg. C.

1.5 Breakout Price #1 Item 5.10 Replace Vestibule Electric Unit Heater Thermostat

- .1 Provide new heating only digital display thermostat and lockable cover.

1.6 Breakout Price #1 Item 5.11 Install Programmable Thermostat in PWGSC Container

- .1 Provide new 7-day programmable heating and cooling thermostat.
- .2 Program thermostat with the following schedule

TAG	DESCRIPTION	HOURS OF OPERATION	MODE
N/A	HVAC System for PWGSC Container	M-F 6:30am to 3:30pm	Occupied
		All other hours	Unoccupied

- .3 The following set points shall be used to program the thermostat.
 - .1 Occupied heating set point: 21 deg. C
 - .2 Unoccupied heating set point 16 deg. C
 - .3 Occupied cooling set point: 24 deg. C
 - .4 Unoccupied cooling set point 28 deg. C

1.7 Split System HVAC Control (Multi Head System)

- .1 General operating sequences are as follows:
 - .1 During occupied periods, fans will run continuously. Heating or cooling will be provided as demanded by individual zones, by manipulation of coil control valves on each unit.
 - .2 During unoccupied hours, fans cycle on demand of unoccupied period set point for heating only. Cooling demands will go unheeded.
- .2 Install factory control accessories.
- .3 Each fan coil is provided with a thermostat and I/O interface for DDC integration.
- .4 An additional room sensor will be required for room temperature feedback to the DDC system for monitoring.
- .5 Install control panels in ceiling space or as located on plans. Provide access for service.
- .6 Provide auxiliary relays controlled by BAS heat cool sensor and control, to activate cooling control circuits in cooling units. Cooling set points through BAS to be set no lower than 23 degrees C.
- .7 When outside air temperature is 18 deg. C (adjustable), the system shall be switched into cooling.
- .8 When outside air temperature is 17 deg. C or below (adjustable), the system shall be switched into heating.
- .9 The thermostat set points shall be set as follows:
 - .1 Heating set point shall be initially set to 21 deg. C.
 - .2 Cooling set point shall be initially set to 24 deg. C.
- .10 Room temperature will be monitored by the DDC room temperature sensor alarm operator if temperature exceeds cooling set point by 1 deg. C or is below heating set point by 1 deg. C.
- .11 Fans shall run on an adjustable schedule initially set to start at Monday to Friday on at 7:00am and off at 5:00pm.
- .12 During unoccupied hours, the system will only run to maintain setback temperatures as follows:
 - .1 Heating unoccupied set point 18 deg. C (Adjustable)
 - .2 Cooling unoccupied set point 28 deg. C (Adjustable)
- .13 In the event that the compressors lock out from low ambient temperature or heating set point cannot be met, backup heating will be provided by the perimeter baseboard systems. These systems will be controlled by the thermostat provided with the fan coils.

1.8 HRV-1 Control

- .1 General operating sequences:
 - .1 During occupied periods, fans will run continuously.
 - .2 During unoccupied hours, fans will be off.
- .2 HRV1-HC-1 shall modulate to maintain the supply air temperature at 21 deg. C during both heating as determined by the air source heat pump mode of operation.
- .3 Monitor the outside air entering temperature at the inlet to the HRV. Ensure the temperature remains above minimum to prevent frost. Initially set to 0 deg. C (Adjust as required based on HRV manufacturers recommendations.)
- .4 Provide additional room sensor (over and above the thermostat provided with the fan coil) for room temperature feedback to the DDC system for monitoring.
- .5 Install control panels in ceiling space or as located on plans. Provide access for service.
- .6 When outside air temperature is 18 deg. C (adjustable), The system shall be switched into cooling.

- .7 When outside air temperature is 17 deg. C or below (adjustable), the system shall be switched into heating.
- .8 The thermostat set points shall be set as follows:
 - .1 Heating set point shall be initially set to 21 deg. C.
 - .2 Cooling set point shall be initially set to 24 deg. C.
- .9 Room temperature will be monitored by the DDC room temperature sensor alarm operator if temperature exceeds cooling set point by 1 deg. C or more or is below heating set point by 1 deg. C or more.
- .10 Fans shall run on an adjustable schedule initially set as follows:
 - .1 Monday to Friday on at 7:00am and off at 5:00pm.
- .11 During unoccupied hours, the system will only run to maintain setback temperatures as follows:
 - .1 Heating unoccupied set point 18 deg. C (adjustable)
 - .2 Cooling unoccupied set point 28 deg. C (adjustable)
- .12 Coil Freeze Protection
 - .1 Monitor the heating water return temperature from HRV-HC-1. If the return temperature deviates more than 22 deg. C from the heating water set point alarm operator.

1.9 Exhaust Fan Control F2

- .1 F-2 is controlled by a wall switch and relay timer installed by Division 16.

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