

MECHANICAL
SPECIFICATIONS

for

**UHN – DI CT 64 Replacement
University Hospital of Northern British Columbia**

1475 Edmonton Street,
Prince George, BC V2M 1S2



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1 GENERAL

1.1 Work Included

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.

1.2 Description of Work

- .1 The fire suppression contractor shall retain the services of a Professional Engineer registered in the Province of British Columbia to provide complete engineering design and field review services including signed and sealed CAD fire suppression drawings and hydraulic calculations.
- .2 The fire suppression contractor's Professional Engineer shall provide field reviews of the work on site as the work progresses and submit signed copies of the reports to Aperta Consulting Inc.
- .3 Submit all documentation to the Authorities Having Jurisdiction, arrange for, pay for and obtain trade permits prior to commencing installation work on site.
- .4 Arrange for, pay for and obtain static and residual water supply pressure information from the utility or municipality in writing and submit a copy of this information with the Shop Drawings. If this information is not available, arrange for, pay for and perform a hydrant flow test.
- .5 Provide all fire suppression systems throughout the buildings including:
 - .1 Wet sprinkler systems in all heated areas
 - .2 Portable fire extinguishers
- .6 Connect to the combined fire suppression / potable water supply main or dedicated fire suppression water main located as shown on the drawings.

1.3 Related Work

- .1 Electrical Division 26
- .2 Plumbing Division 22
- .3 HVAC Division 23

1.4 Codes, Bylaws, Standards and Approvals

- .1 Installation, workmanship and testing shall conform to the following standards:
 - .1 B.C. Building Code 2024
 - .2 National Building Code of Canada 2020.
 - .3 National Fire Protection Association NFPA 10 - Standard for Portable Fire Extinguishers.
 - .4 National Fire Protection Association NFPA 13 - Standard for the Installation of Sprinkler Systems.
- .2 Installation shall be subject to design approval, inspection and test of the Authority Having Jurisdiction.
- .3 All system components shall be of one manufacturer. Normally, materials and devices listed by nationally recognized fire test laboratories will be acceptable.

1.5 Document Submittals

- .1 Provide letters of assurance signed and sealed by the fire suppression contractor's registered Professional Engineer.
- .2 Some Cities or Municipalities may allow sprinkler contractors to perform limited amounts of sprinkler work (such as the relocation or addition of a limited number of sprinklers) under a Trade Permit, without the requirement of submitting Schedules B-1, B-2 and C-B.

Where this scenario is permitted by the City or Municipality, the sprinkler contractor may not, under the scope of this contract, break down the work and take out multiple Trade Permits in order to alleviate submitting Schedules B-1, B-2 and C-B.

- .3 Submit 'Schedule B-1: Assurance of Professional Design and Commitment for Field Review' and 'Schedule B-2: Summary of Design and Field Review Requirements' in accordance with the B.C. Building Code 2024, to the Consultant and to the local Authority Having Jurisdiction at the time of the shop drawing submission.
- .4 Submit static and residual water supply pressure information.
- .5 Submit CAD drawings of all fire suppression sprinkler systems, fire suppression standpipes, clean agent suppression systems, and other fire suppression or fire extinguishing systems.
 1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval.
- .6 Submit hydraulic calculations for all water based fire suppression sprinkler and standpipe systems.
- .7 Submit 'Schedule C-B: Assurance of Professional Field Review and Compliance' in accordance with the B.C. Building Code 2024 to the Consultant and to the local Authority Having Jurisdiction a minimum of 10 working days prior to Occupancy.
- .8 Submit a "Contractor's Material and Test Certificate" for each Underground and each Aboveground section of the work in accordance with the Authority Having Jurisdiction test procedure requirements, to the Consultant and to the local Authority Having Jurisdiction a minimum of 10 working days prior to Occupancy.
- .9 Submit a Backflow Prevention Test Certificate for all backflow prevention devices.
- .10 Submit a signed letter from the fire stopping installation firm on their company letterhead certifying that all penetrations of fire suppression piping through vertical and horizontal rated separations have been fire stopped in accordance with CAN4-S115.
- .11 Obtain form the Division 26 Electrical contractor and submit a copy of the Fire Alarm Verification Certificate.
- .12 Submit maintenance data for all systems and arrange for inclusion in the project Mechanical Maintenance and Operations Manuals as outlined below.
- .13 Submit signed and sealed copies of Record Drawings, Final Design Drawings and / or As-built Drawings as requested by the project Architect, Certified Professional (C.P.), Authority Having Jurisdiction or the Consultant.
- .14 Submit shop drawings as noted below.
- .15 Submit samples as noted below.

1.6 Shop Drawings

- .1 Submit shop drawings for the following items where they are provided for the project:
 - .1 Piping materials.
 - .2 Valves, fittings and grooved joint couplings.
 - .3 Fire extinguishers and cabinets.

1.7 Maintenance Data

- .1 Provide maintenance data for all fire suppression systems complete with a Table of Contents and coordinate with the plumbing and HVAC trades for incorporation into a designated section of the project Mechanical Operation and Maintenance Manual.
- .2 Include a copy of National Fire Protection Association NFPA-25, Standard for the Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

- .3 Detailed instructions for the normal maintenance of all installed equipment including operational procedures, frequency of operational checks, service instructions and trouble shooting instructions. Information provided must be suitable for incorporation into the local Fire Department's operation manual if so requested by the Authority Having Jurisdiction.
- .4 Local source of supply for each item of equipment indicating the manufacturer's and local supplier's company names, addresses, phone numbers, faxes and e-mails.
- .5 Labeling and identification schedules.
- .6 Valve schedule including location, service type and normal position for all systems.
- .7 Warranties, certificates and miscellaneous reports.
- .8 Manufacturer's operating and maintenance brochures, including wiring diagrams.
- .9 Comprehensive description of the operation of the system including the function of each item of equipment within the system.
- .10 Operating electrical switchgear schedule indicating location of equipment.
- .11 Lubrication schedule indicating the recommended lubricants and grades (grease or oil) for all lubricated equipment components.
- .12 Shop drawings for all components as listed in the Shop Drawings clauses above.
- .13 Documentation as listed in the Documentation Submittals clauses above.

1.8 Occupancy Documentation

- .1 The contractor shall submit the following documentation to the Consultant a minimum of 5 working days prior to the project occupancy site walk-through or occupancy date, whichever is scheduled first. The dates will be established by the project architect, project manager or Certified Professional. It is the contractor's responsibility to provide all documentation to the Consultant in a timely manner. If all documentation is not received, the Consultant may not be able to issue their associated Schedule C-B in support of the building occupancy application and any associated consequences shall become the responsibility of the contractor.
- .2 Fire Suppression system letters of assurance Schedules B-1 Assurance of Professional Design and Commitment for Field Review; Schedule B-2 Summary of Design and Field Review Requirements; and Schedule C-B Assurance of Professional Field Review and Compliance from the contractor's fire suppression engineer.
- .3 Fire Suppression system Contractor's Material and Test Certificates for Aboveground Piping and for Underground Piping systems per NFPA-13.
- .4 A copy of the Fire Alarm Verification Certificate for components related to the fire suppression system devices.
- .5 Letter confirming that all penetrations of rated assemblies have been firestopped in conformance with CAN4-S115, on the firestopping installing agencies letterhead.
- .6 Maintenance manuals for fire suppression systems.

1.9 Seismic Protection

- .1 Supply and install sway-bracing hangers on fire suppression piping systems in accordance with NFPA 13 requirements. Generally this shall apply to all crossmains 50 mm [2"] and larger, and shall apply to all feed mains including all standpipe risers. Horizontal piping shall be 2-way bracing and vertical piping shall include 4-way bracing at the tops of all risers. On floor loops, sway-braces are also required at the corners of all loops.
- .2 Power-driven fasteners shall not be used to attach braces to the building structure, unless ULC listed for this service in the seismic zone in which the fire suppression systems are being installed.

1.10 Pipe, Fittings and Couplings

- .1 The responsibility for including for all pipe, fittings, couplings, valves, nipples, drains, test connections and all accessory pipe work for a complete installation is to be included in this Section of the work within the base tender price.
- .2 No extra cost will be considered based on failure of the contractor to allow for extra pipe, fittings and pipe work as required during construction to provide offsets to avoid structural components, and to coordinate with other piping services, ductwork, cable trays, conduits or other obstacles whether shown on the drawings or not.
- .3 All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- .4 All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

1.11 Sprinklers

- .1 The responsibility for allowing for all sprinklers for a complete installation is to be included in this Section of the work within the base tender price. The layout on the drawings shows the general intention of the work and sprinkler locations with respect to other ceiling elements such as ceiling tiles, lights and diffusers. However the contractor shall provide all additional sprinklers as may be required.
- .2 No extra cost will be considered based on failure of the contractor to allow for extra sprinklers as required during construction to conform to all NFPA requirements and the Authority Having Jurisdiction, whether shown on the drawings or not.
- .3 Include sprinklers above and below suspended architectural ceiling panels.
- .4 Include sprinklers in concealed spaces containing exposed combustible construction including exposed wood beams, exposed wood framing and exposed wood ceiling materials.

1.12 Clean Up

- .1 Leave systems operating with work areas clean to satisfaction of the Consultant, Architect or the Owner's representative.

1.13 System Demonstrations

- .1 The fire suppression contractor's Professional Engineer and their licensed journeyman sprinkler fitter shall attend all demonstrations of the fire suppression systems to the Municipal officials, the Fire Department and Aperta Consulting Inc. This may require multiple site visits and multiple demonstrations depending on the scheduling and sequence of demonstrations as may be established by the Architect, Project Manager or General Contractor.
- .2 The fire suppression contractor's Professional Engineer and their licensed journeyman sprinkler fitter shall demonstrate all devices to Aperta Consulting Inc. including all tamper

switches, all flow switches, all test 'n drain assemblies, all dry pipe valves, all pre-action system devices including detection and activation devices.

- .3 Demonstrations to Municipal officials and / or the Fire Department shall not alleviate the requirement to provide an additional demonstration of all devices and components to Aperta Consulting Inc. Partial demonstrations in lieu of full demonstrations shall be at the sole discretion of Aperta Consulting Inc.
- .4 The fire suppression contractor's Professional Engineer and their licensed journeyman sprinkler fitter shall coordinate to have the electrical contractor and / or their fire alarm system contractor present and to provide all necessary walkie-talkies, ladders, smoke canisters etc to provide complete system demonstrations.
- .5 The fire suppression contractor's licensed journeyman sprinkler fitter shall rectify any deficiencies and subsequently drain all dry system piping, reset all devices and leave the systems in a fully operating condition.

2 PRODUCTS

2.1 General

- .1 All materials shall be ULC Listed for the intended service and shall be supplied in original factory packaging.

SPEC NOTE *Add in FM or other approval agencies as may be applicable to the project.*

2.2 Hangers and Supports

- .1 All hangers and supports including seismic restraints shall be ULC Listed and shall conform to the appropriate NFPA standards.
- .2 Toggle hangers or strap hangers are unacceptable.

2.3 Fire Stopping

- .1 Provide fire stopping materials listed in accordance with CAN4-S115 at all pipes penetrating horizontal and vertical fire rated separations.

2.4 Miscellaneous Metal Related to Fire Protection System

- .1 All miscellaneous metal related to the fire suppression systems including all metal back up plates, stands, brackets and supports for all roof, floor or wall supported equipment and piping systems is part of this Section of the work.
- .2 Provide two coats of heavy red oxide primer to all steel components after fabrication, and touch up on site after installation.

2.5 Backflow Prevention Stations

- .1 Provide a ULC Listed double check valve assembly (DCVA) complete with O.S. & Y. inlet and outlet shut-off valves.
- .2 Backflow prevention stations shall be in complete accordance with the manual "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water Works Association.
- .3 Isolation valves shall be provided with supervisory switches connected to supervisory signals at the fire alarm system.

2.6 Isolation Valves:

- .1 Install isolation valves whether shown on the drawings or not at the following locations:
 - .1 At the point where the water service first enters the building.
 - .2 At the base of each standpipe riser.

- .3 At each sprinkler zone.
- .4 At all points as indicated on the drawings.
- .5 At all points where required by the Building Codes, By-Laws or NFPA.

3 EXECUTION

3.1 Pipe Routing

- .1 Install piping to maximize headroom in all areas, including areas without ceilings where the piping is exposed, without interfering with other systems.
- .2 Do not route piping through electrical or communications rooms or closets, elevator machine rooms, or other similar locations without express permission from the electrical consultant. Limit the piping to branch lines that serve those specific rooms where such rooms are required to be sprinklered.

3.2 Grading and Drainage of Piping

- .1 Grade all fire suppression piping so that it can be drained through drain cocks.
- .2 Pipe all sprinkler system drains to floor drains in mechanical service rooms.

3.3 Building Movement

- .1 Install all piping systems, including all take-offs installed within the building such that the piping and connected equipment will not be distorted by expansion, contraction or building settlement.
- .2 Provide offsets and / or piping expansion components at all building expansion joints, all building seismic joints and all firewalls.
- .3 Provide anchors where necessary to control pipe expansion and pipe movement.

3.4 Pipe Sleeves and Escutcheons

- .1 The supply and installation of pipe sleeves and escutcheons for fire suppression system piping is included in this Section of the work.
- .2 Do not cast piping into concrete walls, slabs or masonry walls.
- .3 At exterior wall or slab penetrations, provide sleeves a minimum of 2 nominal pipe diameters larger than the pipe. (i.e. a 300 mm [12"] sleeve for a nominal 200 mm [8"] diameter pipe).
- .4 Install pipe concentric within the sleeves.
- .5 Remove plastic sleeves, where they are used, prior to installation of the pipe penetration. The resulting hole shall be then classified as the sleeve except in wet areas.
- .6 Provide minimum Schedule 10 steel pipe sleeves where piping penetrates masonry walls.
- .7 Extend sleeves 50 mm [2"] above floor slabs in wet areas. Wet areas include penthouse equipment rooms, janitor's rooms, utility rooms and washrooms.
- .8 Seal all penetrations through aboveground exterior walls, and underground exterior walls and slabs including slabs on grade, where no hydrostatic pressure exists, with a flexible, non-hardening, weatherproof caulking compound. Seal around the exterior circumference of the sleeves as well as the annular space between the pipes and the sleeves.
- .9 Seal all penetrations through underground exterior walls and slabs, including slabs on grade, where hydrostatic pressure exists, with mechanical seals such as Link Seal.
- .10 Install chrome plated escutcheons on exposed piping passing through walls, floors and ceilings in finished areas.
- .11 Risers for fire suppression systems with horizontal branch takeoffs passing through sleeves that are set rigidly in the structure adjacent to the risers shall be set to accommodate long term structural movement to avoid imposing stress on these systems.

3.5 Fire Stopping

- .1 Provide fire stopping to CAN4-S115 at all pipes penetrating horizontal and vertical rated separations.
- .2 Smooth the finished surface in a neat and workman like appearance.

3.6 Core Drilling

- .1 The fire suppression contractor shall be on site and coordinate sleeves and block out requirements in accordance with the project construction schedule to minimize coring.
- .2 Arrange and pay for all costs of all core drilling required for fire suppression systems in this Section of the Work.
- .3 X-ray all concrete walls, partitions, shafts, slabs and other concrete or concrete block assemblies prior to coring. The cost of x-raying shall be included in the cost of the Work. Repairs to existing services damaged as a result of core drilling is included in this section of the Work.
- .4 Verify the location of existing service runs and structural reinforcement within existing concrete floors and walls prior to core drilling and cutting. Core drilling and cutting of structural building components shall only take place upon the receipt of specific written approval of the structural consultant. Repairs that may be required to existing services damaged as a result of core drilling is included in this Section of the work.
- .5 Penetrations up to 150 mm [6"] nominal pipe size in precast concrete may be cored on site per the fire suppression contractor. Larger penetrations shall be located and arranged for in precast work with the precast manufacturer prior to shipping to the construction site.

3.7 Backflow Prevention Stations

- .1 Install backflow prevention stations in complete accordance with the "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water Works Association. Mount backflow preventers a maximum of 1.5 meters [5 feet] above the adjacent floor level for servicing.
- .2 Complete testing of all backflow prevention devices shall be carried out under this Section of the work prior to final acceptance of fire suppression systems. Submit a certificate duly signed and witnessed that testing was satisfactorily completed and a include a copy in the project Mechanical Operation and Maintenance Manual.

3.8 Hangers and Supports

- .1 Provide all hangers and supports as outlined in NFPA including supports to adequately secure the piping to restrict movement upon activation of the fire suppression systems including the activation of fire pumps, and charging of the systems through the fire department connections.

3.9 Pressure Gauges

- .1 Provide pressure gauges at the following locations and additional gauges as required by NFPA, the AHJ and the system configuration:
 - .1 Water entry valve station both upstream and downstream of the backflow preventer.
 - .2 Upstream and downstream of all pumps.
 - .3 At the top of all fire suppression standpipe and sprinkler risers.

3.10 Seismic Restraints

- .1 Provide seismic restraints as outlined in NFPA and to the seismic zone listed in the applicable building code or bylaw.

- .2 Anchorage and seismic restraints of the fire suppression systems as listed in the Letters of Assurance Schedules B-1, B-2 and C-B is included in this Section of the work.

3.11 Tests and Inspection

- .1 Furnish all labour, materials, equipment and instruments necessary for all required tests. All work shall be subject to review by the Consultant, Owner's representative, and local Authority Having Jurisdiction.
- .2 Provide at least seventy-two (72) business hours notice for projects within 100 km [60 miles] of the City of Vancouver and a minimum of one hundred and twenty (120) business hours notice for projects greater than 100 km [60 miles] of the City of Vancouver, in advance of making the required tests.
- .3 Tests on fire suppression systems shall include pressure tests and shall conform to the standards of the Authority Having Jurisdiction. Fire department connections and fire pump test header lines shall also be hydrostatically tested.

END OF SECTION

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1 GENERAL

1.1 General

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 The General Conditions, Supplements, Amendments and Mechanical General Requirements shall govern the plumbing sections of the work. This section covers items common to Division 22 series sections and is intended only to supplement the requirements of Division 1.
- .3 Plumbing drawings are diagrammatic and approximately to scale. They establish the scope of the plumbing work and the general location and orientation of the plumbing facilities. Plumbing facilities shall be installed generally in the locations and generally along the routings shown close to the building structure with minimum interference with other services. Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and the intended use of the space through which they pass, unless specifically noted otherwise.

1.2 Related Work

- .1 Electrical Division 26
- .2 Concrete Division 03
- .3 HVAC Division 23
- .4 Trenching and Backfilling Division 33

1.3 Codes, Standards and Approvals

- .1 Installation, workmanship and testing shall conform to the following standards:
 - .1 the British Columbia Building Code.
 - .2 Canadian Gas Association, CGA B149.1-M00, Natural Gas and Propane Installation Code
 - .3 British Columbia Gas and Safety Branch Bulletins.
 - .4 Refer to clause 1.15 in section 23 05 00.

1.4 Shop Drawings

- .1 Submit shop drawings in accordance with Division 1.
- .2 Shop drawings are required for all materials and equipment including, but not limited, to the following:
 - .1 Plumbing permits
 - .2 Cleanouts and access panels.
 - .3 Floor drains.
 - .4 Plumbing fixtures.
 - .5 Trap primers.
 - .6 Valves.
 - .7 Water hammer arrestors.
 - .8 Pipe, fittings and couplings.
 - .9 Fire stopping.

1.5 Maintenance Data

- .1 Refer to Section 23 05 00 Common Work Results for HVAC.
- .2 Manufacturer's operating and maintenance brochures, including wiring diagrams.
- .3 Comprehensive description of the operation of the system including the function of each item of equipment within the system.

- .4 Lubrication schedule indicating the recommended lubricants and grades (grease or oil) for all lubricated equipment components.
- .5 Buried gas pipe test report.

1.6 Record Drawings

- .1 Provide project record drawings for all plumbing systems as specified in Section 23 05 00 Common Work Results for HVAC.
- .2 In addition, as a minimum, during the construction period, keep on site a clean set of drawings marked up, **IN COLOUR**, to reflect the 'As-Built' state, for examination by the Consultant on a regular basis. Include elevations, rough-in details and detailed locations of all hidden services, including locations of maintenance items and their associated identification code (ie. valves). All underground services and/or concealed piping shall be dimensionally located and noted (use gridlines or structure as the reference).
- .3 At the time of 'Substantial Performance' submit to the Consultant one complete full sized **COLOUR** Xerox copy of all Record drawing information produced as per the above section.

1.7 Occupancy Documentation

- .1 The contractor shall submit the following documentation to the Consultant a minimum of 5 working days prior to the project occupancy site walk-through or occupancy date, whichever is scheduled first. The dates will be established by the project architect, project manager or Certified Professional. It is the contractor's responsibility to provide all documentation to the Consultant in a timely manner. If all documentation is not received, the Consultant may not be able to issue their associated Schedule C-B in support of the building occupancy application and any associated consequences shall become the responsibility of the contractor.
- .2 Seismic restraint system letters of assurance Schedules B and Schedule CB from the contractor's seismic restraint engineer.
- .3 Letter confirming that all penetrations of rated assemblies have been firestopped in conformance with CAN4-S115, on the firestopping installing agencies letterhead.
- .4 Copies of pressure test reports for all piping systems on contractor's letterhead.
- .5 Chlorination certificates for potable water systems.
- .6 Balancing reports for domestic hot water recirculation systems.
- .7 Plumbing inspector's final certificate.
- .8 Maintenance manuals for plumbing systems.

1.8 Temporary Usage of Plumbing Equipment

- .1 Plumbing equipment and systems shall not be used without the written permission of the Design Authority and in no circumstances shall be used prior to testing and inspection.

1.9 Existing Piping To Be Removed

- .1 All existing plumbing piping systems that become abandoned as a result of the work or depicted on the drawings for abandonment shall be removed in the following situations:
 - .1 Where specifically noted on the drawings for removal.
 - .2 Where plumbing piping systems are exposed.
 - .3 Where ceilings are opened-up for any reason that would permit such removal to be implemented. In such a case only those portions of the plumbing system that can be removed without taking down more ceiling shall be removed.

1.10 Existing Equipment

- .1 This section shall allow and be responsible for the turning over of all existing fixtures, pumps, valves and other plumbing accessories required to be removed within the terms of contract documents.

- .2 Such equipment shall be stored on site at such location as designated by the owner and shall remain the property of the owner for his future use and/or disposal.

1.11 Acoustical Treatment

- .1 General
 - .1 This project includes special acoustical requirements to ensure low noise levels in noise sensitive areas. The contractor shall in particular give careful consideration to equipment selection and pay close attention to detail during the rough-in stage in order to assure maximum acoustical benefit.
 - .2 The insulation for wall, ceilings and pipe chases as outlined herein is to be provided and installed under another division of work. This section is responsible for ensuring that all special requirement for plumbing systems have been met before the wall or ceilings have been closed in.
- .2 General Scope of Work
 - .1 All plumbing systems located in any walls or within 2 metres [6½'] in any direction of the enclosing walls of the following areas (or of similar areas not specifically named) shall be especially protected against noise transmission as defined herein:
 - .1 AV/TV studio.
 - .2 Conference rooms.
 - .3 Offices.
- .3 Summary of Requirements
 - .1 Drain, Waste and Vent Stacks and Rainwater Leaders:
 - .1 Cast iron pipe and mechanical or neoprene compression gasket hub fittings shall be used. Plastic, copper piping are unacceptable. Waste piping over sound sensitive areas shall be insulated with pre-formed glass fiber insulation.
 - .2 Stubs from appliances in the kitchens or lounge areas may be copper, but a minimum length should be used.
 - .3 Waste connections from appliances and fixtures may be copper to the waste stack.
 - .4 All copper dry vent pipes in walls, chases and ceiling plenums shall be lagged with 25 mm [1"] preformed glass fiber pipe insulation, canvas wrapped and sealed airtight and with one or more coats of heavy enamel paint.
 - .5 Rainwater leaders chases shall be airtight and contain non-compressed RSI 2.11 [R-12] glass fibre insulation in the stud cavities.
 - .2 Domestic Water Operating Parameters:
 - .1 The maximum pressure at any faucet or outlet shall be 275 kPa [40 psi] with at least 10% of maximum rated flow through any pressure reducing valve in the system.
 - .3 Pipe Sizes:
 - .1 The minimum pipe size to faucets or mixing valves of each fixture shall be 12 mm [½"]. The use of 9 mm [¾"] pipes is strictly prohibited.
 - .4 Plumbing Fixtures and Trim:
 - .1 Mixing Valves and Faucets: Quiet cartridge shall be used at mixing faucets and shower valves. Any which subsequently become noisy during the warranty period shall be replaced at no extra charge to the owner.

- .2 Back-to-back Fixtures: Drain line and water supply lines shall be divided at the riser. Tee takeoffs serving back-to-back fixtures are not permitted.
- .3 Quick Acting Valves: All solenoid operated or other quick acting valves shall be equipped with water hammer arresters located as close to the valves as possible.
- .4 Waste Disposal Units: Waste disposal units, if used, shall be resiliently isolated from the sink and waste piping and a limp loop of flexible conduit shall be installed for all electrical connections. Compliance with local codes per installation of flexible connectors shall be checked.
- .5 Fastening to the structure:
 - .1 Piping shall not contact any framing stud or wall surface; or any other conduit, electrical or ventilation fixture that is connected to any wall or ceiling surface.
 - .2 Piping shall not be fastened to a partition which forms part of an adjacent room not served by the pipe in question. Do not secure piping to gypsum wallboard or its supporting frame.
 - .3 Riser clamps shall be isolated from the structure using an approved resilient material between the support collar and the floor structure (Vibro-Acoustics type SN, 30 durometer, 57.15 mm [2¼"] x 57.15 mm [2¼"] in size, or an approved equal). An alternate method is to wrap the pipe with neoprene prior to clamping.
 - .4 Pipe hangers shall be oversized to suit the insulation and shall have a protection shield between the insulation and the hanger.
 - .5 Pipe hangers shall contain 50 durometer, 3.2 mm [1/8"] thick neoprene pads inserted between the hanger saddle and pipe.
- .6 Clearance Around Pipes:
 - .1 All pipe (bare or insulated) shall be clear of contact with studs or gypsum wallboard.
 - .2 Pipes in acoustically critical walls shall be wrapped with a minimum thickness of 6 mm [¼"] of Armaflex or Rubatex sleeving and secured by use of oversized clamps. This is not necessary where the piping is insulated provided that pipe clamps are mounted around the exterior of the insulation. Hard plastic pipe sleeves shall not be used.
- .7 Wall and Slab Penetration by Pipes:
 - .1 Slab penetrating pipes shall be glass fiber wrapped prior to grouting. The grout shall not contact pipes.
 - .2 Gypsum wallboard or plaster wall pipe penetrations shall be 3 mm [⅛"] to 6 mm [¼"] oversized with the pipe centred in the hole and the gap caulked with silicone or other non-hardening sealant.
 - .3 Pipe expansion joints shall be for noise free operation.
- .8 Ceiling, Wall and Other Plumbing Pipe Chases:
 - .1 The interior spaces shall be insulated with non-compressed RSI 2.11 [R-12] batt insulation in the following proportions:
 - .1 Ceiling plenum - 80% of area.
 - .2 Chases - 100% of all four vertical surfaces.
 - .3 Walls - 50% of space containing pipe, and 100% of adjacent stud space.

1.12 Seismic Protection

- .1 Refer to Section 23 05 00 Common Work Results for HVAC.

- .2 In addition to the piping, equipment and systems listed in Section 23 05 00, Seismic Restraint Systems provide seismic restraints on all plumbing piping and equipment including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water and recirculation.
 - .3 Sanitary waste and venting.

1.13 Building Operation During Construction

- .1 In order to minimize operational difficulties for the building's staff, the Contractor must cooperate with the Owner throughout the entire construction period and particularly ensure that noise is minimized.
- .2 Convenient access for the staff and public to the building must be maintained at all times. Minor inconvenience and interruption of services will be tolerated, provided advance notice is given, but the Contractor will be expected to coordinate his work, in consultation with the owner, so the operation of the facility can be maintained as nearly normal as possible.

1.14 Existing Services

- .1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services. Work with the Owner's staff to trace the originating source and points served. Obtain instructions from the Consultant when existing services require relocation or modifications, other than those already indicated in the Contract Documents.
- .2 Arrange work to avoid shutdowns of existing services. Where shutdowns are unavoidable, obtain the Owner's approval of the timing, and work to minimize any interruptions.
- .3 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping may be required.
- .4 Be responsible for any damages to existing system by this work.
- .5 The Owner reserves the right to withhold permission for a reasonable period with respect to any shutdown, if the shutting off of a service will interfere with important operations.

1.15 Risk Reduction Measures

- .1 The constructor's on-site team shall include at least one person with demonstrated knowledge and experience in infection prevention and control during construction. Workers not trained in infection control shall not work alone, shall work with trained personnel or be supervised.
- .2 Risk Reduction Measures for Class 3 and 4 require Infection Prevention and Control Practitioner and project manager review and signature prior to work initiation
- .3 Plumbing Activities
 - .1 Inform environmental services and healthcare staff to report any discolored water and/or water leaks to Plant Services
 - .2 Schedule water interruption during lower user activity (e.g., evenings if possible)
 - .3 Flush water lines prior to use. Submit methods used to disinfect water lines.
 - .4 Water temperature meets health care facility requirements.
 - .5 Use of water diverter preferred for ceiling leaks in risk group 3 & 4 areas.
 - .6 If there are concerns about Legionella, consider hyper-chlorinating stagnant potable water or superheating and flushing all stagnant lines before restoring or re-pressurizing the water system.
 - .7 Disinfect domestic water systems (or sections) that have been stagnant.

- .8 The water lines in the construction area and adjacent client care areas shall be flushed prior to reuse.
- .9 Plumbing materials used in the healthcare facility water systems shall be resistant to build-up of scale and corrosion and shall not promote the growth of bacteria including Legionella.
- .10 Ensure faucet aerators are not installed or used and shall be removed from existing faucets.
- .11 Maintain as dry an environment as possible and report any water leaks that occur to walls and substructures.

2 PRODUCTS

2.1 Product Consistency

- .1 All products utilized on the project shall be as per the shop drawing submissions.
- .2 All products of a similar nature, used in a similar system or application shall be of the same manufacturer throughout the project.

2.2 Access Doors

- .1 Design:
 - .1 Plaster or wet wall construction: 1.70 mm [14 gauge] thick bonderized steel flush with wall or ceiling type with concealed flange. - Acceptable Product: Acudor PS-5030.
 - .2 Masonry or drywall construction: 1.35 mm [16 gauge] thick for 400 mm [16"] x 400 mm [16"] and smaller, 1.70 mm [14 gauge] thick for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange. - Acceptable Product: Acudor UF-5000.
 - .3 Water resistant finished walls, tile, ceramic tile, water resistant dry wall, plaster or wet wall construction in washrooms and other special areas: 1.80 mm [14 gauge] thick stainless steel flush with wall or ceiling type with concealed flange. - Acceptable Product: Acudor PS-5030 stainless.
 - .4 Acoustical tile ceiling and similar block materials: 1.70 mm [14 gauge] thick bonderized steel recessed ceiling type. - Acceptable Product: Acudor AP-5010 or AT-5020.
 - .5 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.
- .2 Minimum Requirements:
 - .1 Materials:
 - .1 Concealed hinges.
 - .2 Adjustable anchoring straps or lugs to suit construction.
 - .2 Finish:
 - .1 Prime coat bonderized steel types.
 - .2 Brushed stainless steel for stainless steel types.
 - .3 Size:
 - .1 200 mm x 200 mm [8" x 8"] for cleanout access.
 - .2 300 mm x 300 mm [12" x 12"] for hand access.
 - .3 600 mm x 600 mm [24" x 24"] for entry access Comment: UBC Hospital requirement

2.3 Cleanouts

- .1 Cleanouts shall be full size for pipe sizes up to 100 mm [4"] and not less than 100 mm [4"] on larger sizes. Cleanouts in inside finished areas shall all be of the same shape either round or square.
- .2 Cleanouts passing through a waterproofed floor or a slab on grade subject to hydrostatic pressure shall possess a clamping collar which shall be clamped to the floor membrane or lead flashing.
- .3 Pipe manufacturers' cleanouts are acceptable for vertical installation at the base of soil and waste stacks or rainwater leaders only.
- .4 Make cleanouts with Barrett type fitting that has a bolted coverplate and gasket, fitting that has a threaded plug, or a cleanout ferrule that is installed in a wye or extended wye.
- .5 Outside area cleanouts shall be of heavy duty construction. - Acceptable Product: Zurn Z1400, Jay R. Smith 4220, Watts, Mifab
- .6 Unfinished concrete area cleanouts shall be of heavy duty construction and have a fully exposed scoriated cover. - Acceptable Product: Zurn Z1400, Jay R. Smith 4229, Watts, Mifab
- .7 Lino or lino tiled area cleanouts shall have the centre portion of cover recessed to receive a piece of tile that matches the adjoining tile. - Acceptable Product: Zurn ZN 1400-X or ZN 1400-TX, Jay R. Smith 4140, Ancon, Mifab
- .8 Ceramic tile floor area cleanouts shall have a fully exposed scoriated cover. - Acceptable Product: Zurn ZN 1400 or ZN 1400-T, Jay R. Smith 4020, Ancon, Mifab
- .9 Terrazzo tile floor area cleanouts have the centre portion of cover recessed to receive terrazzo that matches the adjoining terrazzo finish. - Acceptable Product: Zurn ZN 1400-Z, Jay R. Smith 4180, Ancon, Mifab
- .10 Latex deck area cleanouts. - Acceptable Product: Zurn ZN 1400-DX, Jay R. Smith DX4343/2646Y, Mifab
- .11 Carpet area cleanouts shall be fully concealed with a small raised marker. - Acceptable Product: Zurn ZN 1400-CM, Jay R. Smith 4020-Y, Ancon, Mifab

2.4 Pipe Sleeves and Escutcheons

- .1 Non-combustible pipe penetrations through fire separations that are required to have a fire resistance rating shall be as follows:
 - .1 Fire-rated floor slab sleeves in wet or dry areas shall be as noted on the Standard Detail in Section 15499 [22 06 00].
 - .2 Interior partition (i.e. drywall) shall be as noted on the Standard Detail in Section 15499 [22 06 00].
 - .3 Interior concrete or block wall sleeves shall be steel pipe or removable plastic pipe.
 - .4 All penetrations shall be fire stopped to a CAN4 S-115 listed assembly.
- .2 Combustible pipe penetrations through fire separations that are required to have a fire resistance rating shall be as follows:
 - .1 Intumescent firestopping material contained in a metal housing that is certified for firestopping use. Installation shall be implemented in full compliance with the certified installation procedures. - Acceptable Products: FGC Fireguard Corp. DONUT Firestop for flat surfaces; 3M Brand (Intumescent) Fire Barrier, Dow Corning Fire Stop Intumescent Wrap for Q-deck.
- .3 Pipe penetrations through separations that are not required to have a fire resistance rating shall be as follows:

- .1 Interior concrete or block wall sleeves and floor slab sleeves in dry areas shall be steel pipe or removable plastic pipe.
- .2 Floor slab sleeves in wet areas, outside wall sleeves and roof slab sleeves shall be steel pipe.
- .4 Submit shop drawings(s) of listed assemblies for each type of penetration through a rated assembly.

2.5 Miscellaneous Metal Related to Plumbing Systems

- .1 Frames shall be of welded construction consisting of angle iron sections with 7.9 mm [5/16"] locating strips and anchoring lugs at a minimum of 900 mm [36"] centres.
- .2 Cover plates shall be constructed of minimum 7.9 mm [5/16"] checker plate in sections not exceeding 0.93 square metres [10 ft²] in size with lifting holes at each end of each section. Cover plates shall be provided complete with at least two lifting keys.
- .3 Gasketing between frames and cover plates on sanitary systems shall be of rubber construction.
- .4 Backing Plates shall be adequate to support the use intended and shall be a minimum 4.76 mm [3/16"] in thickness.

2.6 Pipe Bedding

- .1 All buried piping inside the building below floors and slabs except for footing drains, shall be supported on a bed of well compacted sand (ie. 95% Modified Proctor Density). Bedding shall extend from 150 mm [6"] below pipe and shall support the pipe barrel; not the joints and/or couplings. Before backfilling, the complete line shall be inspected and approved by the Authorities Having Jurisdiction.

2.7 Interior Drain, Waste and Vent Pipe and Fittings

- .1 Buried pipe and fittings:
 - .1 Class 4000 cast iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CSA CAN3-B70.
 - .2 Acrylonitrile-Butadiene-Styrene (ABS) Drain Waste and Vent Pipe Fittings conforming to CSA CAN 3-B181.1-M85.
 - .3 Polyvinyl Chloride (PVC) Drain Waste and Vent Pipe and Pipe Fittings conforming to CSA B181.2.
- .2 Above ground pipe and fittings:
 - .1 Class 4000 cast iron mechanical joint pipe and fittings with mechanical joint stainless steel couplings to CSA CAN3-B70 up to 200 mm [8"].
 - .2 DWV copper drainage pipe with cast brass or wrought copper drainage pattern fittings with 50/50 Sn/Pb recessed solder joints.
- .3 Additional requirements:
 - .1 Pressure waste piping from pumping stations and other equipment shall be pressure piping and fittings as specified for domestic water.
 - .2 Plastic (PVC or ABS) piping where used underground shall adapt to approved non-plastic material prior to penetration above the building slab.

2.8 Floor Drains

- .1 Floor drains connected to the sanitary system shall include trap primer connections.

2.9 Pipe and Fittings

- .1 Above ground water pipe inside the building:
 - .1 Ductile iron pipe to ANSI/AWWA C150 and C151, minimum thickness Special Class 54 for use with cut grooved fittings, cement mortar lining to ANSI/AWWA C104 and asphaltic seal coat on the inside. Pipe to be ULC Listed.

- .1 Acceptable Product: Canada Pipe Company Limited.
- .2 Ductile iron pressure fittings to ANSI/AWWA C-606, cement mortar lined, black asphalt coated, NSF 61 listed.
- .3 Ductile iron pressure couplings to ANSI/AWWA C-606 for grooved end AWWA fittings and cut grooved AWWA ductile iron pressure pipe with synthetic gasket, plated carbon steel bolts, alkyd phenolic primer and protective enamel finish.
- .4 Cold water:
 - .1 Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42. All copper water tubing shall be certified by the Canadian Standards Association or Warnock Hersey Professional Services Ltd. to ASTM B88.
- .5 Hot water:
 - .1 Type 'K' hard drawn seamless copper tubing to ASTM B88 or copper pipe to ASTM B42. All copper water tubing shall be certified by the Canadian Standards Association or Warnock Hersey Professional Services Ltd. to ASTM B88.
- .2 Above ground copper water pipe fittings inside the building:
 - .1 Use of the 'T-Drill' system of joining copper piping is unacceptable.
 - .2 Cast brass or wrought copper solder joint pressure fittings with 95/5 Sn/Sb or Silvacite 100 solder joints; or
 - .3 Cast bronze or wrought copper roll grooved pressure fittings with grooved mechanical pipe connector couplings with angle bolt pad and Victaulic style of 'flush seal' gaskets or Shurjoint 'Gap Seal' gaskets.
 - .4 Acceptable Products:
 - .1 Victaulic 'The Copper Connection System for Copper Tubing (CTS)' with 606 couplings, 600 Series fittings and 641 flange adaptors.
 - .2 Shurjoint copper series for copper tube sizes CTS, cast bronze fittings, C305 rigid couplings, C306 reducing couplings, C341 flange adaptors and C307 transition couplings.
 - .5 Exception: Where compression fittings are required they shall be to ANSI B16.22-1973.

2.10 Valves

- .1 Gate: (for shut-off and isolation)
 - .1 50 mm [2"] and smaller, bronze body, solid wedge disc, bronze or stainless steel trim, non-rising stem, 860 kPa [125 psi] rating.
 - .2 Acceptable Products:
 - .1 Solder joint type: Jenkins 300P, Kitz 41, Red & White / Toyo 281A.
 - .2 Threaded joint type: Crane 428, Grinnell 3000, Grinnell Powell 507, Jenkins 810, Kitz 40, Lunkenheimer 2127, Newman-Hattersley A40AT or 33X, Nibco T113, Red & White / Toyo 280A.
 - .3 65 mm [2½"] and larger, flanged ends, cast iron body, solid wedge disc, bronze or stainless-steel trim, rising stem, outside screw and yoke. Acceptable Products: Crane 465-1/2, Grinnell 6020A, Grinnell Powell 1793, Jenkins 404, Kitz 72, Lunkenheimer 1430C, Newman-Hattersley 504, Nibco F617-0, Red & White / Toyo 421A.
- .2 Ball: (in lieu of gate valves or as specified)
 - .1 50 mm [2"] and smaller, brass two piece body, blow-out proof stem, PTFE seats, brass chrome plate ball, lever handle operator, 1035 kPa [150 psi] rating.

- .2 Acceptable Products:
 - .1 Solder joint type: Red & White / Toyo 5049A, Apollo 70-100, Crane, Grinnell 171S, Jenkins, Kitz 59, Lunkenheimer 746FS or 747FS, MAS B-4, Newman-Hattersley, Nibco, Watts, Worcester.
 - .2 Threaded joint type: Red & White / Toyo 5044A, Apollo-70-200 Series, Crane 93-TF, Grinnell 171N, Jenkins-1101-T, Kitz 58, Lunkenheimer 746F or 747F, MAS B-3, Newman-Hattersley 1969AT, Nibco T-580-BR, Watts B-6000, Worcester 4211-RT.
- .3 Globe: (for throttling, bypass and make-up applications)
 - .1 50 mm [2"] and smaller, bronze body, bronze or stainless steel trim, 860 kPa [125 psi] rating.
 - .2 Acceptable Products:
 - .1 Solder joint type with bronze bevel type disc: Crane 1320, Grinnell 3200, Grinnell Powell 650, Jenkins 300P, Kitz 10, Lunkenheimer 2125, Newman-Hattersley A41SE, Nibco S-211-B, Red & White / Toyo 212,
 - .2 Threaded joint type with composition type disc: Crane 7, Grinnell 3210, Grinnell Powell 650TD, Jenkins 106A, Kitz 03, Lunkenheimer 2942, Newman-Hattersley 13, Nibco T-211-Y, Red & White / Toyo 220.
 - .3 265 mm [2½"] and larger, flanged ends, cast iron body, bronze or cast iron bevel-type disc, bronze or stainless steel trim, rising stem, outside screw and yoke.
 - .4 Acceptable Products: Crane 351, Grinnell 6200A, Grinnell Powell 241, Jenkins 2342, Kitz 76, Lunkenheimer 3731, Newman-Hattersley 731, Nibco F-718-B, Red & White / Toyo 400A.
- .4 Check: (for horizontal installation)
 - .1 50 mm [2"] and smaller, threaded joint type, bronze body, bronze or stainless steel swing disc holder with Teflon disc, 860 kPa [125 psi] rating.
Acceptable Products: Crane 37, Grinnell 3330, Grinnell Powell 578, Jenkins 4092, Kitz 22, Lunkenheimer 2144, Newman-Hattersley A60AT, Nibco T-413-B, Red & White / Toyo 236.
 - .2 65 mm [2½"] and larger, flanged ends, cast iron body, bronze or cast iron swing disc, bronze or stainless steel trim, 860 kPa [125 psi] rating.
Acceptable Products: Crane 373, Grinnell 6300A, Grinnell Powell 559, Jenkins 587, Kitz 78, Lunkenheimer 1790C, Newman-Hattersley 651, Nibco F-918-B, Red & White / Toyo 435A.
 - .3 With "Shurjoint" **copper** grooved end pipe system, use Shurjoint style SJ-C900 bronze body grooved end swing check valve with a rubber encapsulated disk, 250 psi rating
- .5 Balance: (for domestic hot water recirculation)
 - .1 30 mm [1¼"] and smaller, globe lockshield, for maximum system temperature, bronze body and trim, Teflon; polytetrafluoroethylene (PTFE), disc, female by male union connection, 690 kPa [100 psi] rating.
 - .1 Acceptable Products: Dahl 13012 or 13013 with memory stop, Dunham Bush 840A, Red & White / Toyo 250LS or 251LS, Grinnell GBV-T threaded, Tour & Anderson circuit balancing valve
 - .2 40 mm [1½"] and larger, plug type, wrench adjustable stop, for maximum system temperature, semi-steel body, resilient plug seals, EPT or RS 55, max. 120°C [250°F] operating temperature, 860 kPa [125 psi], threaded end connections for up to 50 mm [2"], flanged end connections on 65 mm [2½"] and larger.

- .1 Acceptable Products: DeZurik 435 with 487 adjustable stop, Homestead Ballcentric, Newman-Hattersley 170M or 171M, Grinnell GBV-T or GBV
- .6 Pressure reducing:
 - .1 6 mm [¼"] to 9 mm [3/8"] ,860 kPa [125 psi] rating.
 - .1 Acceptable Products: Watts 215, Cash Acme, Singer.
 - .2 12 mm [½"] to 50 mm [2"], 860 kPa [125 psi] rating.
 - .1 Acceptable Products: Watts 223, Braukman, Conbraco, Cash Acme, Singer.
 - .3 65 mm [2½"] and larger, 860 kPa [125 psi] rating.
 - .1 Acceptable Products: BCA 317 PR, Clayton 90 or 90B, Singer 106PR.
- .7 Pressure reducing valve with integral low flow bypass:
 - .1 40 mm [1½"] and larger, 860 kPa [125 psi] rating.
 - .1 Acceptable Products: Watts PV-10-06M, Clayton, Singer, Wilkins.
- .8 Drain Valves and Hose Bibbs:
 - .1 Hose Bibbs: Lockshield globe type with bronze body and trim suitable for maximum system operating pressure.
 - .1 Acceptable Products: Dahl 2316.
 - .2 Drain Valves: Ball type with brass body, cap & chain and chrome plated brass ball.
 - .1 Acceptable Products: Kitz 58CC, Red & White / Toyo 5046, Dahl.
 - .3 Stop and Drain Valves: Emco 10151
- .9 Solenoid:
 - .1 Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, UL and CSA approved, 120 volt.
 - .1 Acceptable Products: ASCO

2.11 Vacuum Breakers

- .1 Pressure type:
 - .1 CSA approved, mechanically independent spring loaded poppet type check valve with a downstream spring loaded air inlet valve, with upstream and downstream isolation valves and test cocks.
- .2 Atmospheric type:
 - .1 CSA approved, bronze body, chrome plate finish where exposed.
 - .1 Acceptable Products: Conbraco 38-100; Febco 710 / 715A; Watts 288A, 288AC; Wilkins 30; Rainbird
- .3 All vacuum breakers shall be sized in accordance with the following table:

Pipe Size mm [in.]	Pressure Type Size mm [in.]	Atmospheric Type Size
12 - 25 [½ - 1]	12 [½]	Full Pipe Size
30 - 40 [1¼ - 1½]	19 [¾]	Full Pipe Size
50 - 75 [2 - 3]	25 [1]	Full Pipe Size

2.12 Water Hammer Arrestors

- .1 Bellows or piston manufactured style with stainless steel casing and welded stainless steel nesting bellows if of the bellows style. Air chambers are unacceptable.
- .2 Acceptable Products: Zurn Z-1700 Series bellows style, Jay R. Smith, Ancon, Amtrol, Watts; Precision Plumbing Products Inc. piston style.

2.13 Pipe Joints

- .1 Solders and fluxes having a lead content and self-cleaning acid type fluxes shall not be used.
- .2 All copper to steel or iron and flanged adaptors shall be brass, not copper.
- .3 All unions or similar interconnections between dissimilar metals shall be dielectric couplings.
 - .1 Acceptable Products: Epco Dielectric Pipe Fittings, Victaulic dielectric waterway

2.14 Air Vents

- .1 Design: Automatic float type, 1035 kPa [150 psi] max. operating pressure.
- .2 Acceptable Products: Armstrong 11-AV, Maid-o-Mist 71, Taco 426, Amtrol.

2.15 Trap Seal Primers

- .1 Provide flow actuated type priming device piped to nearest fixture so that device will introduce regulated amount of water into trap whenever fixture is used.
Acceptable Products: Watts A200-T, Zurn, Watts, Jay R. Smith
- .2 Provide pressure actuated type priming device piped where the nearest fixture is remote to the floor drain requiring trap priming.
Acceptable Products: Precision Plumbing Products Model P-1.

3 EXECUTION

3.1 Piping Installation

- .1 General:
 - .1 Install piping straight, parallel and close to walls and ceilings, with a fall of not less than 1:100 for gravity piping and with a slope to drain cocks, fixtures or equipment for all pressure piping unless otherwise indicated on drawings. Use standard fittings for direction changes. Provide drain cocks as required.
 - .2 Install groups of piping parallel to each other; spaced to permit application of insulation, identification, and service access, on trapeze hangers.
 - .3 Where pipe size differs from connection size to equipment, install reducing fitting close to equipment. Reducing bushings are not permitted.
 - .4 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.
 - .5 Ream ends of pipe and tubes before installation.
 - .6 Lay copper pipe so that it is not in contact with dissimilar metal and will not be crimped or collapsed. All joints on cast or ductile iron pressure service piping shall be made electrically conductive.
 - .7 Install flanges or unions to permit removal of equipment without disturbing piping systems.
 - .8 Clean ends of pipes or tubing and recesses of fittings to be jointed. Assemble joints without binding.
 - .9 Install piping to connections at fixtures, equipment, outlets and all other appurtenances requiring service. Trap and vent waste connections to fixtures. Grade all vents to drain back to waste piping.
 - .10 Plug or cap pipe and fittings to keep out debris during construction.
 - .11 Jointing of pipe shall be compatible with type of pipe used.
 - .12 Non-corrosive lubricant or teflon tape shall be applied to the male thread of threaded joints.
 - .13 Flush and clean out piping systems after testing.

- .2 Equipment Drainage:
 - .1 Install drain valves at low points.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
- .3 Expansion and Contraction and Building Seismic Joints:
 - .1 Support piping to prevent any stress or strain.
 - .2 Install pressure piping with loops and offsets which will permit expansion and contraction to occur without damaging the pressure piping system.
- .4 Buried Piping:
 - .1 Lay pipe on compacted bedding of clean, coarse sand free from clay, snow or ice, organic matter or stones.
 - .2 Do not lay pipe in water or when conditions are unsuitable.

3.2 Access Doors

- .1 Install access doors at all concealed cleanouts, traps, unions, expansion joints, valves, control valves, air vents, water hammer arrestors, special equipment, trap primers, vacuum breakers and any other equipment for which subsequent periodic access will be required during the life of said equipment.
- .2 Locate access doors so that all concealed items are readily accessible for adjustment, operation, maintenance and replacement.
- .3 Do not locate access doors in feature walls or ceilings without the prior approval of the Consultant. Locate in service areas and storage rooms wherever possible.

3.3 Cleanouts

- .1 Install cleanouts at the following locations:
 - .1 Building drain leaving building on the upstream side of exterior wall.
 - .2 Changes of direction of more than 45 degrees in drainage piping.
 - .3 Nominally horizontal branch or building drain at intervals of not more than 7.5 metres [25'] for pipe sizes 65 mm [2½"] and less, 15 metres [50'] for 75 mm [3"] and 100 mm [4"] pipe sizes, and 26 metres [85'] for pipe sizes larger than 100 mm [4"].
 - .4 Fixture drain of a sink, kitchen piping or grease waste piping at intervals not exceeding 7.5 metres [25'] for pipe all sizes.
 - .5 Base of soil or waste stacks and rainwater leaders.
 - .6 As called for by the B.C. Building Code.
- .2 Cleanouts which are located low on walls shall be located 75 mm [3"] minimum above the top of the baseboard or minimum 200 mm [8"] above finished floor level where there is no baseboard.
- .3 Cleanouts shall be coordinated with all millwork and with all other obstructions, shall be placed in readily accessible locations and shall have sufficient clearance for rodding and cleaning.
- .4 Extend cleanouts to the finished floor or wall unless exposed in a basement room, pipe tunnel or accessible crawlspace.
- .5 Cleanouts in wet floor areas shall extend above the floor in walls or be provided with gasketted waterproofed tops.
- .6 Cleanouts on outside drains shall be brought to grade and anchored in a concrete collar.

3.4 Hangers and Supports

- .1 Refer to section 23 05 00.

3.5 Pipe Sleeves and Escutcheons

- .1 Supply and installation of pipe sleeves is included in this section of the work. Install chrome plated escutcheon plates on exposed piping passing through walls, floors and ceilings in finished areas. Sleeves shall be concentric with pipe and; except at fire separations, shall be sized to allow for the continuity of insulation.
- .2 Extend sleeves 50 mm [2"] above floor slabs in wet areas. Wet areas include equipment rooms, janitor's rooms, kitchen areas, utility rooms, bath areas and washrooms.
- .3 Extend sleeves through outside walls to 25 mm [1"] beyond the exterior face and caulk with flexible caulking compound.
- .4 Where removable plastic sleeves are used they shall be removed prior to pipe penetration and the resulting hole shall be then classified as the sleeve.
- .5 Extra high vertical risers for cold water and hot water systems with many horizontal branch takeoffs passing through sleeves set in rigid structure adjacent to the main risers, sleeves shall be set to accommodate long term structural movement to avoid imposing stress on these systems.

3.6 Core Drilling and Cutting

- .1 Arrange and pay for the cost of all core drilling and cutting for plumbing systems in this section of the work.
- .2 Verify the location of existing service runs and structural reinforcement within existing concrete floors and walls prior to core drilling and cutting. Coring and cutting of structural building components shall only take place upon the receipt of specific written approval of the structural engineer.
- .3 X-ray all concrete walls, partitions, shafts, slabs and other concrete or concrete block assemblies prior to coring. The cost of x-raying shall be included in the cost of the Work. Repairs to existing services damaged as a result of core drilling is included in this section of the Work.
- .4 Penetrations up to 150 mm [6"] nominal pipe size in precast concrete may be cored on site by the plumbing trade. Larger penetrations shall be located and arranged for in precast work with the precast manufacturer prior to shipping to the construction site.

3.7 Miscellaneous Metals Relating to Plumbing Systems

- .1 All miscellaneous metal related to the plumbing systems including, all mild steel checker plate sump covers and frames, all metal back up plates and supports for all ceiling or wall supported equipment or plumbing fixtures, all steel covers or cages to protect exposed piping subject to mechanical damage is part of this section of the work.
- .2 Lay out the location of all pipe trenches and sumps and coordinate the construction thereof with the responsible contractor.
- .3 Frames and coverplates which are out of level or warped are unacceptable.
- .4 Prime coat after fabrication with two coats of red primer.
- .5 See separate division of specification for finish painting requirements.

3.8 Piping Expansion

- .1 All piping systems, including all take-offs shall be so installed within the building that the piping and connected equipment will not be distorted by expansion, contraction or settling.
- .2 If circumstances on the job require additional changes in direction from those shown on the drawings, the configuration shall be adjusted to suit at no extra cost.
- .3 Anchors shall be installed where necessary to control expansion. Expansion joints or loops shall be installed on hot water piping where required.

3.9 Project Photographs

- .1 The Contractor shall provide digital photographs in "jpeg" format to the Consultant complete with a text description of each photograph including the date, system type, materials used, and location/direction for all sections of underground piping prior to backfilling. Submit the photographs via email and/or disc as requested by the Consultant.
- .2 Provide additional digital photographs of the work as requested by the Consultant to assist in the resolution of RFIs, prior to covering the work.

3.10 Floor Drains

- .1 Install floor drains set low to provide proper drainage.
- .2 Generally do not locate floor drains in the center of mechanical rooms. Locate floor drains in close proximity to the equipment and / or devices that will be discharging water to them, such that drain connections from the equipment and / or devices can be piped to the floor drains without creating a tripping hazard.

3.11 Safes, Flashing and Vent Terminals

- .1 Terminate all vent terminals a minimum of 25 mm [1"] above the water level at which roof drainage overflows through roof overflow scuppers or drains.
- .2 All cleanouts passing through walls or floors subject to hydrostatic pressure and waterproofed by means other than a membrane shall be provided with clamping collars and flashings of 25 kg/m² [5 lb/ft²] lead.
- .3 Chloraloy 240 lining material may be used as an alternate to lead under built-up floor sinks and showers; and at floor drains and cleanouts. Materials shall be solvent welded to manufacturer's installation instructions. Lead shall not be used on roofs where the roofing material is applied by a torch-on method. Dow reinforced sheeting 45R may be used as an alternative to lead in all applications except in areas in which a rubberized or plastic membrane must be clamped to a drain.
- .4 Supply and fix 25 kg/m² [5 lb/ft²] sheet lead flashings to all cleanouts and drains. Securely fix to flashing clamps and extend 300 mm [12"] beyond edge of cast iron fittings.
- .5 Supply and install 25 kg/m² [5 lb/ft²] lead safes under built-up showers and mop sinks on any floor which is not slab-on-grade. The safes shall extend across the floors and up walls and curb to a minimum height of 150 mm [6"] and shall be turned into the floor drain flange, unless specifically noted otherwise. Seams shall be welded (burned), not soldered. Any metal shall be commercially pure lead only. Treat both sides of the safe with two coats of asphalt.
- .6 Vent flashing minimum 450 mm x 450 mm [18" x 18"] base dimension shall terminate flush with the top of 300 mm [12"] high vent pipe and the gap between the flashing and pipe shall be closed with a 25 kg/m² [5 lb/ft²] separate lead cap 75 mm [3"] high. The main flashing shall not be turned over the pipe.
- .7 Provide intrinsically safe barriers for all sump pumps located within parking garages, vehicle service or parking bays and in other areas which can receive fuels.

3.12 Piping

- .1 Do not install ABS, PVC or other plastic piping upstream of any oil interceptors.
- .2 Do not install piping with glued joints at temperatures below those recommended by the solvent manufacture.

3.13 Valve Installation

- .1 Combined domestic and fire suppression systems:
 - .1 Coordinate with the fire suppression contractor regarding all valves in piping systems that serve both domestic and fire suppression systems. These valves shall be ULC and / or FM labeled for use in fire suppression systems and shall be

- provided with supervisory switches for monitoring their valve position by the fire alarm system.
- .2 Where possible, disassemble solder end joint valves before soldering.
 - .3 Where disassembly and the subsequent reassembly is not possible, the contractor shall give special regard to solder jointing in order not to damage, melt or deform and valve parts.
 - .4 Shut Off Valves:
 - .1 Install shut-off or isolation valves whether shown on the drawings or not at the following locations:
 - .1 At the point where the water service first enters the building.
 - .2 At the base of each building riser.
 - .3 At each main branch supply point; provide a valve on each outlet leg from the tee or cross.
 - .4 At each single plumbing fixture (i.e. normally this requirement is satisfied by the provision of the angle valve specified with the specific fixture).
 - .5 At each single piece of equipment.
 - .6 At all points as indicated on the drawings.
 - .7 At all points where the plumbing code requires same.
 - .5 Balancing Valves:
 - .1 Install circuit balancing valves in hot water recirculating branch mains and branch connections to return mains whether indicated on drawings or not.
 - .6 Pressure Reducing Valves:
 - .1 Pressure reducing valve stations, as a minimum shall consist of the following:
 - .1 A high flow or main pressure reducing valve; which shall be one pipe size smaller than the incoming or outflowing building service, and shall be provided with a strainer, a reducer, shut off valve and union on the inlet side and a union, reducer and a shut off valve on the outlet side.
 - .2 A low flow pressure reducing valve; which shall be a minimum 25 mm [1"] in size, and shall be provided with a strainer, shut off valve and union on the inlet side and a union and shut off valve on the outlet side.
 - .3 A pressure gauge and gauge cock on each side of the pressure reducing valve.
 - .4 Where a pressure reducing valve with integral low flow bypass is used the piping, fittings and accessories shall be arranged as described in 3.2.6.1.1 above.
 - .2 Set main pressure reducing valve at 415 kPa [60 psi] outlet pressure.
 - .3 Set small flow pressure reducing valve at 35 kPa [5 psi] higher outlet pressure than main pressure reducing valve.
 - .7 Drain Valves:
 - .1 Install drain valves 18 mm [3/4"] minimum, or line size where the piping is smaller than 18 mm [3/4"].
 - .2 Install a hose-end adaptor, cap and chain on the discharge side of each drain valve or pipe to drain where indicated.

3.14 Vacuum Breaker Installation

- .1 Install at each fixture or item of equipment where contamination of the domestic water system can occur.

- .2 Vacuum breaker installation shall be in complete accordance with the manual "Cross Connection Control Manual" published by the Pacific Northwest Section of the American Water Works Association.
- .3 All atmospheric type vacuum breakers shall be installed at least 300mm [12"] above flood level rim of fixture.
- .4 All vacuum breakers serving fume hoods shall be installed outside fume hood.
- .5 Provide drain pan with water deflecting enclosure on concealed pressure type vacuum breakers with drain line to appropriate drain.
- .6 Complete testing of all vacuum breakers shall be carried out under this section of the work prior to final acceptance of plumbing systems. A certificate shall be submitted duly signed and witnessed that testing was satisfactory.

3.15 Flanges and Unions

- .1 Provide on all connections to pumps, reducing valves, control valves, fixtures, and equipment.
- .2 Connections up to and including 50 mm [2"] size shall be all bronze union, 1,035 kPa [150 psi] rating with ground seat; larger connections shall be flanged.

3.16 Pressure Gauges

- .1 Install pressure gauge at all pump suction and discharge points and at each pressure reducing station inlet and outlet.

3.17 Water Hammer Arrestors

- .1 Size in accordance with the Plumbing and Drainage Institute PD1-WH-201 sizing procedures.
- .2 Install on branch lines to flush valves, solenoid valves, self-closing faucets, quick closing valves and on refrigeration, kitchen and laundry equipment incorporating solenoid valves.

3.18 Pipe Joints

- .1 Install dielectric type couplings where copper piping and accessories connect to plumbing equipment such as steel storage tanks, pressure reducing stations and ductile iron pipe.
- .2 Where the water service enters the building terminate at the edge of the building and excavation with a Smith Blair standard sleeve coupling having stainless steel nuts and bolts. Bridge the excavation with ductile iron pipe.
- .3 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.
- .4 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.

3.19 Air Vents

- .1 Install at all high points in domestic hot water recirculation system.
- .2 Install on tees and not on horizontal piping or radiused elbows.
- .3 Install 12 mm [½"] minimum isolating gate valve ahead of each air vent.
- .4 Pipe all air vent discharge connections separately to nearest building drain using 6 mm [¼"] hard drawn copper.

3.20 Trap Seal Primers Valves

- .1 Provide floor drain trap primers in watercloset rooms and other areas connected to the sanitary sewer in accordance with the plumbing code and as designated on the drawings.
- .2 Locate at locations that are readily accessible by the building maintenance staff.

3.21 Testing and Inspection

- .1 Furnish all labour, materials, instruments, etc. necessary for all required tests. All work shall be subject to inspection by local plumbing inspector and review by the Consultant.

- At least forty-eight (48) business hours [2 business days] notice shall be given in advance of making the required tests for projects.
- .2 All leaks shall be corrected by remaking the joints. The systems shall be retested until no leaks are observed.
 - .3 No plumbing system or part thereof shall be covered until it has been inspected and approved by the Plumbing Inspector.
 - .4 If any plumbing system or part thereof is covered before being inspected or approved, it shall be uncovered upon the direction of the Plumbing Inspector or Consultant.
 - .5 Testing shall consist of hydraulic pressure testing at 1,400 kPa [200 psi] for 8 hours.
 - .6 Submit signed and dated pressure test reports for all sections of the water distribution systems.
 - .7 Tests on the sanitary waste and storm drainage systems shall consist of hydraulic pressure testing of 3000 mm [10'] for 8 hours.

3.22 Flushing and Chlorination of Water Lines

- .1 Thoroughly flush all water piping so that it is free from scale, sediment and debris as soon as possible after the system is filled with water.
- .2 On completion of installation and testing, all water piping shall be pre-flushed, chlorinated and flushed again in accordance with AWWA C-601.
- .3 Retain a reputable firm qualified to supervise and inspect the chlorination and flushing procedures and perform chemical biological tests as required.
- .4 The piping shall be chlorinated so that a chlorine residual of not less than 10 ppm remains in the water after standing for 24 hours. Hypochlorite and water is recommended as a disinfectant. AWWA C-601 recommends the amount of chlorine required.
- .5 Submit to the Consultant a certificate from the testing firm stating that chlorination and flushing has been successfully completed.
- .6 On projects with water piping being connected to the existing water distribution system including system piping modifications, piping extensions, tenant fit outs etc flushing and chlorination of all new piping remains a requirement. Provide all required isolation, fill and drain valves required to flush and chlorinate the new piping without impacting the existing system piping.

END OF SECTION

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1 GENERAL

1.1 Conformance

- .1 The General Conditions, Supplements and Amendments shall govern this Division (read in conjunction with Instructions to Tenderers / Bidders). This section covers items common to all sections of Division 22 and 23 and is intended to supplement the requirements of Division 01.

1.2 Work Included

- .1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein, in complete accordance with applicable codes and ordinances.
- .2 The word "Provide" shall mean "Supply and Install" the products and services specified. "As Indicated" means that the item(s) specified are shown on the drawings.
- .3 Provide materials, equipment and plant, of specified design, performance and quality; and, current models with published certified ratings for which replacement parts are readily available.
- .4 Provide project management and on-site supervision to undertake administration, meet schedules, ensure timely performance, ensure coordination, establish orderly completion and the delivery of a fully commissioned installation.
- .5 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
- .6 The most stringent requirements of this and other mechanical sections shall govern. Should inconsistencies exist such as the drawings disagreeing within themselves or with the specifications, the better quality and/or greater quantity of work or materials shall be estimated upon, performed and furnished unless otherwise ordered by the Consultant in writing during the bidding period.
- .7 All work shall be in accordance with the PROJECT Drawings and Specifications and their intent, complete with all necessary components, including those not normally shown or specified, but required for a complete installation.
- .8 Provide seismic restraints for all required equipment, piping and ductwork.
- .9 Connect to equipment specified in other sections and to equipment supplied and installed by other Contractors or by the Owner. Uncrate equipment, move in place and install complete; start-up and test. Include all field assembly of loosely/separately packaged accessories.
- .10 The construction shall comply with CSA CSA-Z8000: Canadian health care facilities and CSA-Z317.13: Infection control during construction, renovation, and maintenance of health care facilities. Coordinate with other Divisions to provide a complete construction plan to comply with the standards.
- .11 "Consultant" shall mean Aperta Consulting Inc.

1.3 Standard of Acceptance

- .1 Means that item named and specified by manufacturer and/or catalogue number forms part of specification and sets standard regarding performance, quality of material and workmanship and when used in conjunction with a referenced standard, shall be deemed to supplement the standard.
- .2 Where two or more manufacturers are listed, the manufacturer's name shown underlined or shown with a model name and/or number was used in preparing the design. Tenders may be based on any one of those named, provided that they meet every aspect of the drawings and specifications.

- .3 Where other than the underlined manufacturer or scheduled/specified manufacturer is selected or approved, include for the cost of any resulting work (both under this Division and other Divisions) and any necessary redesign of installation or structure. Submit redesign drawings for review with Shop Drawings. Maintain installation, access and servicing clearances. Redesign drawings shall be to scale and of a standard equal to the Project Drawings.
- .4 Where two or more items of equipment and/or material, of the same type, are required, provide products of a single manufacturer.
- .5 Install and test all equipment and material, in accordance with the detailed recommendations of the manufacturer.
- .6 A visible manufacturer's nameplate shall indicate manufacturer's name, model number, serial number, capacity data, electrical characteristics and approval stamps.

1.4 Addition of Acceptable Manufacturers

- .1 Material/products considered to satisfy the specification, but of a manufacturer other than those named in the Equipment Supplier Schedule may be submitted to the Consultant for consideration not later than five (5) working days prior to closing of tender or of bid depository subtrade tender whichever is earlier.
- .2 Addition of manufacturer's names to the specifications will be by addendum only.

1.5 Tender Inquiries

- .1 All contractor queries during the tender period shall be made in writing to the consultant. Contractor queries will be collected and suitable addenda will be issued for clarification. No verbal information will be issued by the consultant's office during tender. All tender queries may be e-mailed, faxed, mailed or couriered to the consultant's office. No telephone questions will be answered.

1.6 Equipment List

- .1 Submit a completed Equipment List, showing the make of equipment and material included in the Tender, including the names of the subtrades, 10 days after the award of the Contract.
- .2 The equipment list shall be a full list of materials intended for installation.

1.7 Detailed Price Breakdowns

- .1 Ten (10) days after the award of contract submit price breakdowns.
- .2 In particular cases more detail may be necessary to properly assess a change order or progress claim. This additional information, which could include all suppliers and all sub-contractors, shall be supplied when requested by the Consultant.
- .3 Mark-up information is required for change orders but is optional on the original tender price.

1.8 Progress Claims

- .1 Submit with each progress claim a progress claim summary.
- .2 Submit detailed price breakdowns on a photocopy of the Detailed Price Breakdown Form for each section of the mechanical work listed on the Progress Claim Summary Form and for each separate mechanical change order item exceeding \$20,000.00.

1.9 Scheduling

- .1 Coordinate with Division 1, Construction Schedule.
- .2 Incorporate within the Construction Schedule, a complete and realistic schedule, integrated with, and recognizing the reliance on, other divisions of the work. Take into account the lead time for the review of operating and maintenance manuals, commissioning, verification of system operation by the Consultant and the demonstration

and instruction to the Owner. The schedule shall include but not limited to the following items:

- .1 Installation and testing of piping systems and equipment.
- .2 Installation and cleaning of duct systems and equipment.
- .3 Chemical cleaning and treatment of piping.
- .4 Control system installation.
- .5 Air/Water balancing
- .6 Air measurements of existing systems prior to any renovation work.
- .7 Connection of electrical services to equipment by electrical contractor.
- .8 Start-up of mechanical equipment and systems.
- .9 Check-out of control systems.
- .10 Commissioning of mechanical systems.
- .11 Demonstration of systems and equipment to Consultant.
- .12 Demonstration of systems and equipment to Owner.
- .13 Preparation of maintenance manuals and as-built drawings.
- .14 Submission of the various documents required prior to substantial performance.

1.10 Responsibilities

- .1 Visit the site before tendering. Examine all local and existing conditions on which the work is dependent. No consideration will be granted for any misunderstanding, of work to be done, resulting from failure to visit the site.
- .2 Ensure that equipment does not transmit noise and/or vibration to other parts of the building, as a result of poor installation practice.
- .3 Where the Contract Documents do not contain sufficient information for the proper selection of equipment for bidding, notify the Consultant during the tendering period. If clarification is not obtainable, allow for the most expensive arrangement. Failure to do this shall not relieve the Contractor of responsibility to provide the intended equipment.
- .4 Examine carefully the mechanical, electrical, structural and architectural drawings and confirm that the work under this Sub-Contract can be satisfactorily carried out without changes to the building as shown on these plans.
- .5 Be responsible for prompt installation of this work in advance of concrete pouring or similar work. Provide and set sleeves where required.
- .6 During freezing weather, protect all materials in such a manner that no harm can be done to installations already in place and/or to materials and equipment on the job.
- .7 On completion of the work, all tools and surplus and waste materials shall be removed and the work left in a clean and perfect condition.

1.11 Coordination

- .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 Owner, without the Consultant's written approval.
- .2 The drawings indicate the general location and route to be followed by the piping and ductwork. Where details are not shown on the drawings or only shown diagrammatically, the pipes and ductwork shall be installed in such a way as to conserve head room and interfere as little as possible with the free use of space through which they pass. Service lines shall run parallel to building lines. All ducts and pipes in the ceiling shall be kept as tight as possible to beams or other limiting members at high level. All pipes and ducts shall be coordinated in elevation to ensure that they are concealed in the ceiling or structural space provided unless detailed otherwise on drawings.

- .3 Work out jointly all interference problems on the site with other trades and coordinate all work before fabricating, or installing any material or equipment. Where necessary produce interference drawings showing exact locations of mechanical equipment within service areas, shafts and the ceiling space. Ensure that all materials and equipment fit into the allotted spaces and that all equipment can be properly serviced and replaced, if and when required. Advise the Consultant of space problems before fabricating, or installing any material or equipment. Demonstrate to the Consultant on completion of the work that all equipment installed can be properly, safely serviced and replaced, if and when required. Remove and replace improperly installed equipment to satisfaction of the Consultant at no extra cost. Extras for improper coordination and removal of equipment to permit remedial work shall not be allowed.
- .4 When open web structural joists are used, obtain structural shop drawings to ensure adequate space is available for installation of pipes and ductwork.

1.12 Hoists and Scaffolds

- .1 Provide all necessary interior movable or roller scaffolds, platforms, lifts and ladders for the installation of the mechanical work.

1.13 Review of Work

- .1 The Consultant representative shall review all work prior to it being concealed. All piping below ground must be approved prior to covering.
- .2 All work shall be approved by all authorities having jurisdiction.
- .3 All openings shall be sealed appropriately in particular in fire rated walls and floors. Sealing shall be reviewed prior to covering.

1.14 Permits

- .1 Obtain all required permits and pay all fees therefore and comply with all Provincial, Municipal, and other legal regulations and by-laws applicable to the work.
- .2 Arrange for inspection of all Work by the authorities having jurisdiction. On completion of the Work, furnish final unconditional certificates of approval by the inspecting authorities.

1.15 Codes, Regulations, and Standards

- .1 Divisions 22 and 23 work shall conform to the following codes, regulations and standards, and all other codes in effect at the time of award of Contract, and any others having jurisdiction. The latest revision of each code and standard shall apply unless otherwise specified in the contract documents:
 - .1 By-laws
 - .1 Local Building By-laws.
 - .2 Canadian Standards Association
 - .1 CAN/CSA-B51-14: Boiler, Pressure Vessel and Pressure Piping Code.
 - .2 CAN/CSA-B52-13: Mechanical Refrigeration Code.
 - .3 CAN/CSA-C22.1-09: Canadian Electrical Code, Part I
 - .4 CSA-Z8000: Canadian health care facilities
 - .5 CSA-Z317.13: Infection control during construction, renovation, and maintenance of health care facilities
 - .3 Province of British Columbia
 - .1 B.C. Building Code
 - .2 B.C. Plumbing Code
 - .3 B.C. Fire Code
 - .4 B.C. Safety Authority Safety Standards Act

- .5 B.C. Safety Authority Power Engineers, Boiler, Pressure Vessel and Refrigeration Safety Regulation
- .6 B.C. Safety Authority Gas Safety Regulation
- .7 B.C. Electrical Safety Branch Bulletins
- .8 B.C. Occupational Health & Safety (OHS) Regulations, WorkSafeBC
- .4 Underwriter's Laboratories of Canada
 - .1 CAN/ULC-S110-07: Test for Air Ducts
 - .2 CAN/ULC-S111-07: Fire Test for Air Filter Units
 - .3 CAN/ULC-S112.1-M90: Leakage Rated Dampers for Use in Smoke Control Systems
 - .4 CAN/ULC-S115-05: Fire Tests of Fire Stop Systems
- .5 SMACNA Publications
 - .1 ANSI/SMACNA 006 – HVAC Duct Construction Standards, Metal and Flexible
 - .2 Fire, Smoke, and Radiation Damper Installation Guide
 - .3 Guidelines for seismic restraints of mechanical systems
 - .4 SMACNA 008 – IAQ Guidelines for Occupied Buildings Under Construction
 - .5 SMACNA 016 – HVAC Air Duct Leakage Test Manual, 2nd Edition
 - .6 SMACNA 1108 Accepted Industry Practice for Industrial Duct Construction
 - .7 SMACNA 1819 – Fire, Smoke & Radiation Damper Installation Guide for HVAC Systems
 - .8 ANSI/SMACNA 006 – HVAC Duct Construction Standards – Metal and Flexible
- .2 Where multiple standards apply, the most stringent requirement shall be incorporated into the work.
- .3 Where these specifications specifically indicate requirements more onerous than the aforementioned codes, these specifically indicated requirements shall be incorporated into the work.

1.16 Warranty

- .1 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.
- .2 Take note of any extended warranties specified.
- .3 Furnish a written warranty stating that all work executed under this Division will be free from defects of material and workmanship for a period of one (1) year from the date of substantial performance, which shall include one (1) complete summer and one (1) complete winter of uninterrupted operation. Warranty shall include any part of equipment, units or structures furnished hereunder that show defects in the works under normal operating conditions and/or for the purpose of which they were intended.
- .4 The above parties further agree that they will at their own expense promptly investigate any mechanical or control malfunction, and repair or replace all such defective work, and all other damages thereby which becomes defective during the time of the guaranty-warranty.

1.17 Energy Consumption

- .1 Consultant may reject equipment submitted for approval or review on basis of performance or energy consumed or demanded.

1.18 Asbestos

- .1 All material / products installed shall be free of asbestos.

1.19 Workmanship

- .1 Workmanship shall be in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.
- .2 The Consultant 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 appearance.
- .3 Employ only tradesmen holding valid Provincial Trade Qualification Certificates. Tradesmen shall perform only work that their certificate permits. Certificates shall be available for review by the Consultant.

1.20 Performance Verification of Installed Equipment

- .1 Installed mechanical equipment whose performance is questioned by the Consultant, may be subject to performance verification as specified herein.
- .2 When performance verification is requested, equipment shall be tested to determine compliance with specified performance requirements.
- .3 The Consultant will determine by whom testing shall be carried out. When requested, the contractor shall arrange for services of an independent testing agency.
- .4 Testing procedures shall be reviewed by the Consultant.
- .5 Maintain building comfort conditions when equipment is removed from service for testing purposes.
- .6 Promptly provide the Consultant with all test reports.
- .7 Should test results reveal that originally installed equipment meets specified performance requirements, Owner will pay all costs resulting from performance verification procedure.
- .8 Should test results reveal that equipment does not meet specified performance requirements, equipment will be rejected and the following shall apply:
 - .1 Remove rejected equipment. Replace with equipment, which meets requirements of Contract Documents including specified performance requirements.
 - .2 Replacement equipment will be subject to performance verification as well; using the same testing procedures on originally installed equipment.
 - .3 Contractor shall pay all costs resulting from performance verification procedure.

1.21 Drawings and Measurements

- .1 Drawings are generally diagrammatic and are intended to indicate the scope and general arrangement of work and are not detailed installation drawings. Do not scale the drawings. Obtain accurate dimensions from the Architectural and Structural drawings.
- .2 Consult the architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from the Consultant where definite locations are not indicated.
- .3 Take field measurements, where equipment and material dimensions are dependent upon building dimensions.
- .4 Where imperial units have been indicated in brackets [] following the requirements in SI units, the conversion is approximate and provided for convenience. The SI units shall govern.

1.22 Building Operation During Construction

- .1 In order to minimize operational difficulties for the building staff, the various trades must cooperate with the owner throughout the entire construction period and particularly ensure that noise is minimized.

1.23 Existing Services

- .1 Protect all existing services encountered. Every effort has been made to show the known existing services. However, the removal of concealing surfaces may reveal other existing services. Work with the Owner's staff to trace the originating source and points served. Obtain instructions from the Consultant when existing services require relocation or modifications, other than those already indicated in the Contract Documents.
- .2 Arrange work to avoid shutdowns of existing services. Where shutdowns are unavoidable, obtain the Owner's approval of the timing, and work to minimize any interruptions.
- .3 Shutdowns, to permit connections, will be carried out by maintenance staff.
- .4 In order to maintain existing services in operation, temporary relocations and/or bypasses of piping and ductwork may be required.
- .5 Be responsible for any damages to existing systems by this work.

1.24 Shop Drawings/Product Data

- .1 Process
 - .1 Shop drawings/product data shall be submitted and as specified in Plumbing sections.
 - .2 Shop drawings/product data shall be reviewed, signed and processed as described in the General Conditions, in Division 1.
 - .3 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Consultant.
 - .4 Do not order equipment or material until the Consultant has reviewed and returned shop drawings.
 - .5 Shop drawings shall be reviewed by the General Contractor and Mechanical Sub-Contractor indicating that the shop drawings have been reviewed, coordinated with the work and that the shop drawings are submitted without qualifications. Shop drawings shall bear the 'reviewed' stamp dated and initialled by the General Contractor and Mechanical Sub-Contractor prior to submitting the shop drawings to the consultant. Shop drawings, which do not bear the contractors and sub-trades 'reviewed' stamp, initials and date will be rejected and sent back as 'not reviewed'.
 - .6 Submit samples, in addition to drawings, of all items, which in the Consultant's judgment, can be better examined for capacity, quality, finish or detail by sample rather than by drawings. Samples shall be submitted before equipment or material is ordered.
 - .7 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert to the specified product and manufacturer for this project.
- .2 Content
 - .1 Shop drawings submitted title sheet.
 - .2 Data shall be specific and technical.
 - .3 Identify each piece of equipment.
 - .4 Information shall include all scheduled data.
 - .5 Material for maintenance and operating manuals is not suitable.
 - .6 Advertising literature will be rejected.
 - .7 The project shall be identified on each document.
 - .8 Information shall be given in Imperial Units.
 - .9 The shop drawings/product data shall include:

- .1 Clearly mark submittal material using arrows, underlining or circling to show differences from specified ratings, capabilities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps, seals, material, or painting.
- .2 Dimensioned construction drawings with plans and sections showing size, arrangement and necessary clearances, with mounting point loads.
- .3 Weights of all major equipment for review by the appropriate Consultant.
- .4 Mounting arrangements.
- .5 Detailed drawings of bases, supports and anchor bolts.
- .6 Capacity and performance characteristics indicated on performance curves for fans and pumps.
- .7 Sound Power Data, where requested.
- .8 Motor efficiencies on motors 1H.P. and larger.
- .9 List of the manufacturers and figure numbers for all valves, traps and strainers.
- .10 Control explanation and internal wiring diagrams for packaged equipment.
- .11 Control system drawings including a written description of control sequences relating to the schematic diagrams.
- .12 Submit as a shop drawing, an electrical equipment list for any equipment supplied by the mechanical contractor or his subtrades. The list is to be submitted in a timely fashion so that the electrical contractor can utilize the list as a final check prior to ordering motor control centres, starters, or disconnects. The list is to indicate the following:
 - .1 The horsepower size and number of motors.
 - .2 The minimum circuit amps (MCA) for packaged equipment such as roof top units.
 - .3 The voltage and phase of the motors.
 - .4 Whether or not a starter or a disconnect is included as part of the package.
- .3 Format
 - .1 Black line prints 216 mm x 280 mm [8-1/2" x 11"] or 280 mm x 430 mm [11" x 17"].
 - .2 Larger drawings may be submitted on reproducible sepia with space for stamps and signatures - master set plus one working copy.
 - .3 An assembly of related components, e.g. grilles, registers and diffusers or radiation with sheet metal cabinets, etc. between covers with the contents, identified by model number, listed on the front cover with item identification numbers.
 - .4 A brochure for plumbing fixtures between covers with the contents named with model numbers listed on the front cover with item identification numbers.
- .4 No. of copies
 - .1 Provide number of copies indicated in Section 01 33 00 – Submittal Procedures with a minimum of two (2) copies for the Consultant.
- .5 Coordination
 - .1 Where mechanical equipment requires electrical connections, power or other services, the shop drawings shall also be circulated through the Electrical

Contractor (or other "services" contractor(s)) prior to submission to the Consultants.

- .6 Keep one (1) copy of shop drawings and product data, on site, available for reference.

1.25 Construction Detail Samples

- .1 Samples of repetitive items encountered during the construction of this project are required to establish quality control.
- .2 Samples shall be provided within 30 days of contract award or 14 days prior to installation on site of specific samples.
- .3 Construction details are samples specifically required for this project and are required as follows:
 - .1 Ductwork Fittings - high pressure (including joints and sealer).
 - .2 Ductwork Fittings - low pressure (including joints and sealer).
 - .3 Fire damper installation (mounted in mock stud wall c/w breakaway duct section, 40" x 40" overall).
 - .4 Pipe sleeve installation - fire rated wall/floor.
 - .5 Pipe sleeve installation - non-fire rated wall.
 - .6 Pipe anchor and sleeve detail.
 - .7 Internal duct insulation c/w butt joints, open ended duct, high velocity and low velocity details.
 - .8 Pipe hangers.
 - .9 Typical restraint details for equipment, ductwork and piping.
- .4 Acceptance of the standard of the sample is strictly at the discretion of the Consultant.
- .5 Once the quality of the sample has been accepted it shall establish the quality expected throughout the remainder of the project.

1.26 Salvage

- .1 All piping, ducting and equipment, which becomes redundant and is no longer required due to the work in this Contract, shall be completely removed.
- .2 All existing items which need to be removed, and which have a reasonable salvage value, such as fans and motors, air terminals, plumbing fixtures, and valves, shall be carefully removed and handed over to the Owner. Handing over to the Owner includes moving to Owner's designated storage place on site. These items shall not become the property of the Contractor. Obtain a written receipt from the Owner detailing each of the items handed over.
- .3 Remove all redundant material not required by the Owner from the site.
- .4 Allow for all costs of removal and disposal of the materials and equipment not required by the Owner.

1.27 Reused Equipment

- .1 Where existing equipment is being relocated and re-used, check and report on the condition to the Consultant before reinstallation.

1.28 Temporary or Trial Usage

- .1 Temporary or trial usage by the Owner of mechanical equipment supplied under this contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.29 Spare Parts

- .1 Provide spare parts as follows:

- .1 One set of V-belts for each piece of machinery.
- .2 One filter cartridge for each filter installed (pre and final filters).

1.30 Demolition

- .1 Reference Standards
 - .1 CSA Z8000 Canadian Healthcare Facilities.
 - .2 Unless otherwise specified, carry out demolition work in accordance with CAN/CSA-S350-M1980, Code of Practice for Safety in Demolition of Structures.
- .2 Existing Conditions
 - .1 Visit and examine the site and note all characteristics and irregularities affecting the work of this section.
- .3 Protection
 - .1 Cease operations and notify the Prime Consultant immediately for special protective and disposal instructions when any asbestos materials are uncovered during the work of this section.
 - .2 Prevent debris from blocking surface drainage inlets and mechanical and electrical systems, which remain in operation.
- .4 Salvageable Materials
 - .1 Except as otherwise indicated, salvageable materials from areas of demolition shall become the property of the Owner at his discretion. All material removed from the building not handed over to the Owner for salvage under this project shall be removed from site and disposed of as required by any applicable disposal regulations.
- .5 Existing Services
 - .1 Disconnect and cap all mechanical services in accordance with requirements of local authority having jurisdiction. Natural gas supply lines shall be removed by the gas company or by a qualified tradesman in accordance with gas company instructions.
 - .2 Maintain all building services as required during demolition/removal of existing.
- .6 Demolition
 - .1 Carry out demolition in a manner to cause as little inconvenience to the adjacent occupied building area as possible. Coordinate the activity with the Owner and/or the Consultant.
 - .2 Carry out demolition in an orderly and careful manner.
 - .3 All removal of existing equipment, pipes and ductwork that may affect occupied areas of the building to be done outside of regular office hours or as scheduled with the Owner.

1.31 Project Close-Out Requirements

- .1 The project closeout requirements are specifically listed in each section of this specification. The following is a summary of those requirements. Refer to detailed specifications in each section for further, detailed requirements. Items designated with an asterisk are required to be submitted one week prior to required date of Schedule C. All life safety systems must be operational and tested and demonstrated to Consultant prior to issuance of Schedule C. This includes items such as fire pump, sprinklers, stair pressurisation fans, smoke exhaust system, parkade exhaust CO system (as applicable).
 - .1 Controls:
 - Controls system completion report (check sheets).
 - Controls system final electrical approval certificate.
 - As built control drawings.

- Control training signed off by Owner (Indicate dates of training in letter and attendance).
- List of control manuals and documents turned over.
- Printed copy of control program and database. Printed to disk in word format acceptable.
- Disc of control system database.
- Calibration report for refrigeration, carbon monoxide and CO sensors.
- Airflow station start up and calibration report.
- .2 Heating/Cooling
 - Seismic inspection report.
 - Valve tag chart.
 - As built drawings.
 - Welding certificate and x-ray reports.
 - Flushing and cleaning of piping report.
- .3 HVAC
 - As built drawings.
 - Duct cleaning certificate.
- .4 Miscellaneous
 - Identification Schedules.
 - Seismic Engineer's Letters of Assurance
 - Demonstrations to Owner signed off by Owner.
 - List of incomplete or deficient work prepared by each sub trade.
 - Contractor's Letter of Guarantee
 - Signed-off substantial completion inspection report.
 - List of spare parts signed off by Owner.
- .5 Plumbing
 - Final plumbing acceptance inspection report from city/municipality.
 - Valve tag chart for plumbing system.
 - Pressure test reports for sanitary, storm and domestic water.
 - As built drawings.
 - O&M information.
 - Final gas inspection acceptance inspection.
 - Inside water service chlorination report.
- .6 Manufacture start-up and other reports including:
 - Fire stop letter of assurance.

1.32 Substantial Performance Requirements

- .1 Before the Consultant is requested to make an inspection for substantial performance of the work:
 - .1 Commission all systems and prove out all components, interlocks and safety devices.
 - .2 Submit a letter certifying that all work (including calibration of instruments and balancing of systems) is complete, operational, clean and all required submissions have been completed.
 - .3 A complete list of incomplete or deficient items shall be provided. If, in the opinion of the Consultant, this list indicates the project is excessively incomplete, a substantial completion inspection will not be performed.
- .2 The work will not be considered to be ready for use or substantially complete until the following requirements have been met:
 - .1 All reported deficiencies have been corrected.

- .2 Testing and balancing completed.
- .3 Operating and Maintenance Manuals completed.
- .4 "As built" record drawing ready for review.
- .5 System Commissioning has been completed and has been verified by Consultant.
- .6 All demonstrations to the owner have been completed.
- .3 Letters of assurance will not be issued until the following requirements have been met:
 - .1 All items listed in .1 and .2 above have been completed.
 - .2 Certificate of Penetrations through Separations.
 - .3 Seismic engineer's letter of assurance and final inspection report.
 - .4 Certificate of Substantial Performance.
 - .5 Signed off copy of final inspection report.
 - .6 Plumbing inspection report / card.

1.33 Deficiency Holdbacks and Deficiency Inspections

- .1 Work under this Division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.
- .2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for Total Performance of Division 22 and 23 work have been met and verified.

1.34 Risk Reduction Measures

- .1 The constructor's on-site team shall include at least one person with demonstrated knowledge and experience in infection prevention and control during construction. Workers not trained in infection control shall not work alone, shall work with trained personnel or be supervised.
- .2 Risk Reduction Measures for Class 3 and 4 require Infection Prevention and Control Practitioner and project manager review and signature prior to work initiation
- .3 Ventilation Control
 - .1 Disable the ventilation system in the construction/renovation area until project is completed.
 - .2 Monitor the need to change and/or clean filters in construction/ renovation area.
 - .3 Maintain differential negative pressure 7.5 Pa (0.03 WC) within the construction zone, and negative air pressure 2.5 Pa (0.01 WC) within the anteroom by using certified portable HEPA equipped air filtration units.
 - .4 Ensure continuous monitoring of negative pressure by using differential monitoring device connected to an alarmed data recorder. The differential monitoring device must be located on the adjacent or exterior side of the barrier; no closer than five metres of the construction site entry.
 - .5 Monitoring equipment shall be maintained, zeroed and calibrated in accordance with manufacturers' instructions. The alarm set point for the differential pressure monitoring device shall be established by the MDT. In no case shall the alarm set points be set lower than 2.5 Pa with a maximum alarm delay of 90s.
 - .6 The constructors shall record the pressure differentials in a log sheet daily
 - .7 Construction air handling unit (CAHU) must be performance verified, operated and maintained in accordance with CSA Z317 standards.
 - .8 Air exhausted from construction, maintenance, and repair areas must be HEPA filtered, preferably directly outside and away from intake vents.

- .9 Exhaust air shall not be discharged into Risk Group 3 or 4 areas. (measures related to re-circulated air require approval from the MDT).
- .10 If a HEPA filtered vacuum is used as a CAHU, it must meet the CAHU requirements specified in the CSA Z317 standards.
- .11 Ensure ventilation system is functioning properly and is cleaned if contaminated by soil or dust after construction project is complete.
- .12 All opened ductwork must be sealed and remain sealed until installation and completion of connections and/or construction.
- .13 All plumbing & HVAC systems shall be supplied, installed & commissioned in accordance to CSA Z 317.1, CSA Z 317.2 & CAN/CSA Z 8001
- .14 Ensure ventilation system is functioning properly and is cleaned if contaminated by soil or dust after construction project is complete.
- .15 Ensure ventilation systems are working properly in adjacent areas.

2 PRODUCTS

2.1 Access Doors

- .1 Supply flush mounted access doors, for installation by Building Trades in furred ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, and where specifically indicated.
- .2 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12"x12"] for hand entry; 200mmx200mm [8"x8"] for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary. Size to suit masonry modules when located in a masonry wall.
- .3 Locate access doors so that all concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in panelled, feature or special finish walls, without prior approval of the Consultant.
 - .1 Access doors in fire separations of 3/4 hour rating, and higher, and firewalls shall have a compatible fire rating and a ULC label with tamper-proof latch, self-closing.
- .4 Minimum Requirements:
 - .1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.
 - .2 Plaster or wet wall construction: 14 gauge bonderized steel flush with wall or ceiling type with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030.
 - .3 Masonry or drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"] and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange.
 - .1 Acceptable Product: Acudor UF-5000.
 - .4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 gauge stainless steel flush with wall or ceiling type with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030 stainless.
 - .5 Acoustical tile ceiling and similar block materials: 14 gauge bonderized steel recessed ceiling type.

- .1 Acceptable Product: Acudor AP-5010 or AT-5020.
- .6 Feature wall construction: Recessed wall type that is selected to complement and conform with the architectural module, treatment, or panelling. The size shall conform to adjacent finishes.
- .7 Access panels in fire separations and fire walls shall have a compatible fire rating and ULC label. (i.e. Acudor Fire Rated FW-5050 or FB-5060).
- .5 Standard of Acceptance: Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.

2.2 Operating AND Maintenance Manuals

- .1 Prepare instruction manuals which include equipment manufacturers' operating and maintenance bulletins, a report on the balancing of the air and water systems and a report on chlorination of water mains.
- .2 The manufacturers' bulletins shall include:
 - .1 General description of the equipment and their operation.
 - .2 Normal maintenance and minor trouble-shooting of each major item.
 - .3 Wiring diagrams.
 - .4 Control diagrams.
 - .5 Spare parts list.
 - .6 Local source of supply.
- .3 Submit three copies in suitably labelled stiff Accopress binders, to the Consultant at least 10 days prior to the substantial performance inspection date.

2.3 Record Drawings

- .1 Comply with requirements indicated in Section 01 78 00 - Closeout Submittals.
- .2 Maintain one set of contract drawing white prints, including all supplementary and revision drawings on site, solely for the purpose of recording, in red, any change and/or deviation from the Contract Drawings as it occurs. Include elevations and detailed locations of buried services.
- .3 The set of white prints will be provided to the contractor by the Consultant at the contractors cost.
- .4 The marked-up set of prints shall be reviewed on site monthly by the consultant during the construction process. This review will form a requirement for approval of the monthly progress claim.
- .5 Back filling shall not occur until underground services dimensions are marked on the prints,
- .6 The Record Drawings shall include, but not limited to, the following changes and shall be recorded daily:
 - .1 Size, location, arrangement, routing and extent of ductwork, piping, terminal units, equipment, fixtures, clean-outs, valves, rough-in, etc. above and below grade inside the building and including dimensioned locations of buried piping from building walls
 - .2 Location of fire dampers.
 - .3 Location of all heat traced piping and associated controllers.
 - .4 Location of back flow preventers.
 - .5 Location of water hammer arrestors.
 - .6 Water lines: Invert elevations to be recorded at each junction, changes of direction and every 30 m [100 ft.] run.
 - .7 Sanitary Sewers: Invert elevations and locations to be recorded at each clean-out.

- .8 Storm Drains & Sewers: Invert elevations to be recorded at each manhole, clean-out, changes of direction and every 30 m [100 ft.] run.
- .9 Gas Lines: Invert elevations to be recorded at each junction, at building entry point and at changes of direction.
- .10 All services located below ground level and in or below a building slab.
- .11 All valve stations, trap stations, coils dampers and ductwork not easily accessible.
- .12 Location, tagging, and numbering of all valves.
- .7 CAD Drafting:
 - .1 Obtain the services of the Consultant or an approved CAD draftsman to transfer all changes to amend the CAD files in the latest version of AutoCAD.
 - .2 Include all details from revision drawings, addenda, and change orders. Label each drawing in the lower right corner in letters of at least 12mm [1/2"] high as follows:
 - .1 "AS BUILT DRAWINGS," Contractors name and date.
 - .3 Provide one set of check prints for review by Consultant.
 - .4 Upon acceptance by the Consultant, provide computer CAD files and one set of plots.
 - .5 Note: The Contractor will be required to sign a standard Aperta Consulting Inc. / Contractor agreement entitled "Authorization to Use CAD drawing files." The agreement restricts the use of the CAD files to the purpose of "as-built" only and determines the editing procedures.
 - .6 Hand over completed reproducible as-built drawings with Operating and Maintenance Manuals.

2.4 Testing Balancing & Commissioning

- .1 BALANCING - AIR SYSTEMS
 - .1 Note: prior to demolition, take airflow measurements of the existing supply air system. Ensure air quantities in unaltered areas are maintained and / or re-instated at conclusion of the work.
 - .2 Adjust all new and existing terminal boxes and air outlets to air quantities indicated on the drawings and in this specification. Where outlet quantities are not indicated, divide capacity equally among all outlets.
 - .3 Balance chilled water supply to coils in AHU's (interior and perimeter).
 - .4 Adjust air terminals to obtain the optimum air distribution pattern.
 - .5 Permanently mark the final balance position on all balance dampers and adjustable air turning devices.
 - .6 Re-balance interior and perimeter air handling units. Allow for any required sheave changes to obtain design volume.
 - .7 Submit two (2) copies of the balancing report to the engineer within two (2) weeks after substantial completion. Failure to submit the report within the specified time will result in the work being done by the owner and the costs deducted from the final payment.
 - .8 Balancing shall be performed to the following accuracies:
 - .1 Air terminal outlets +/- 10%
 - .2 Air central equipment +/- 5%
 - .3 Hydronic terminals +/- 10%
- .2 COOPERATE WITH THE BALANCING AGENCY AS FOLLOWS:
 - .1 Make corrections as required by the balancing agency.

- .2 Allow balancing agency free access to site during construction phase. Inform balancing agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.
- .3 Operate automatic control system and verify setpoints during balancing.
- .4 Provide balancing agency a complete set of mechanical drawings and specifications.
- .3 **BALANCING VALVES AND DAMPERS**
 - .1 Provide and install balancing valves, dampers and other materials requested from the balancing agency and/or necessary to properly adjust or correct the systems to design flows, without additional cost to the owner.
- .4 **COMMISSIONING AND DEMONSTRATION**
 - .1 Be responsible for the performance and commissioning of all equipment supplied and re-used under the HVAC sections of Division 15.
 - .2 Confirm operation and review condition of all existing air valves and associated control devices in the renovated area. Submit report noting any remedial work required.
 - .3 At the conclusion of commissioning, demonstrate the operation of the systems to the consultant and then to the owner's operating staff.
 - .4 At the completion of the commissioning, testing, balancing and demonstration submit to the consultant a letter certifying that all work specified under this contract is complete, clean and operational in accordance with the specification and drawings.
- .5 **DEFICIENCY HOLDBACKS AND DEFICIENCY INSPECTIONS**
 - .1 Work under this division which is still outstanding when substantial performance is certified will be considered deficient and a sum equal to at least twice the estimated cost of completing that work will be held back.
 - .2 It is expected that outstanding work will be completed in an expeditious manner and the entire holdback sum will be retained until the requirements for total performance of Division 15 work have been met and verified.

2.5 Seismic Restraint Systems

- .1 Restraints shall meet the requirements of the British Columbia Building Code.
- .2 **Seismic Restraint Design and Inspection**
 - .1 Arrange and pay for the services of a B.C. registered professional structural engineer who specializes in the restraint of building elements. This structural engineer, herein referred to as the seismic engineer shall provide all required engineering services related to seismic restraints of non-vibration isolated equipment, ductwork and piping as indicated below.
 - .2 The seismic engineer shall provide assistance to the contractor as necessary during the course of restraint of equipment, ductwork and piping.
 - .3 The seismic engineer shall inspect the completed seismic installation and shall submit a statutory declaration to the consultant stating that the complete seismic installation is installed in accordance with his drawings and instructions and it complies with the regulatory requirements. Prior to substantial performance, the seismic engineer shall provide letters of assurance for all mechanical, plumbing and fire protection systems applicable to the scope of the project.
- .3 **Submittals**
 - .1 Submit shop drawings of all restraining devices, not covered in the SMACNA Guidelines, including details of attachment to the structure, either tested in an

- independent testing laboratory or approved by a B.C. registered professional engineer.
- .2 Proposed inserts or connections to structure to follow directions of project structural consultant.
- .4 Application
 - .1 Provide cable restraints on all isolated equipment and seismic restraint on all other equipment, piping and ductwork, all in general accordance with SMACNA Guidelines (see Products).
- .5 Scope of Work
 - .1 Provide restraint on all piping, ductwork, equipment and machinery, which is part of the building mechanical service systems to prevent injury or hazard to persons and equipment and to retain equipment in its normal position in the event of an earthquake. This specification covers equipment, which is not specifically covered in SMACNA.
 - .2 Provide all seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.
 - .3 When equipment is mounted on concrete housekeeping pads, and / or concrete curbs the anchor bolts shall extend through the pad into the structure.
 - .4 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.
 - .5 Seismic restraints may only be omitted where permitted by SMACNA.
- .6 Products
 - .1 General
 - .1 Mason Type SCB (Seismic Cable Brace) slack cable restraints supplied by Vibra-Sonic Control.
 - .2 Restraint systems as indicated in 1998 SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems" (second edition), Seismic Hazard Level SHL A. If lesser restraint than recommended by SMACNA SHL A is proposed to meet local Code seismic requirements, provide shop drawings of details certified by a B.C. registered structural consultant.
- .7 Execution
 - .1 General
 - .1 It is the responsibility of the contractor to ascertain that an appropriate size device be selected for each individual piece of equipment.
 - .2 The following are guidelines for some items not covered in SMACNA but certified shop drawings should still be submitted. Note that this list is not intended to cover all equipment requiring restraints.
 - .2 Air Terminals
 - .1 Where air terminals are installed in mechanical grid ceilings, provide at least two 12 ASWG galvanized steel wire seismic security bridles per air terminal tied either to the building structure or to ceiling hanger wires.
 - .2 Attach security bridles at opposite corners of each air terminal and in such a manner that the air terminal cannot fall.
 - .3 Provide all necessary brackets for attachment of security bridles to the air terminals.

- .3 Isolated Piping and Equipment
 - .8 Install cables using appropriate grommets, shackles, and other hardware to ensure alignment of the restraints and to avoid bending the cables at connecting points.
 - .9 Connect slack cable restraints to ceiling hung equipment in such a way that the axial projection of the wires passes through the centre of gravity of the equipment.
 - .10 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), and tie back to the ceiling slab at an angle not exceeding 45 degrees to the slab.
 - .11 On piping systems, provide transverse slack cable restraints at a maximum spacing of 12 m [40 ft] and longitudinal restraints at 24 m [80 ft] maximum spacing, or as limited by anchor/slack cable performance. For pipes greater than NPS10, reduce transverse restraint spacings to 6.0 m [20 ft]. Small pipes may be rigidly tied to big pipes for restraint, but not the reverse.
 - .12 Transverse bracing for one pipe section may also act as longitudinal bracing for the pipe connected perpendicular to it, provided the bracing is installed within 600 mm [24"] of the elbow or T, and if the connected pipe is the same or smaller in size. Do not use branch lines to restrain main lines.
 - .13 Provide flexibility in piping joints or sleeves where pipes pass through building seismic or expansion joints.
 - .14 At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the centre of gravity of the riser. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed the transverse spacings discussed above for horizontal pipes, with guide clearance not exceeding 3 mm [1/8"].
 - .15 Vary adjacent spacing of restraints on a piping run by 10% to 30% to avoid coincident resonances.
 - .16 Install restraints at least 50 mm [2"] clear of all other equipment and services.
 - .17 Adjust restraint cables such that they are not visibly slack, or such that the flexibility is approximately 40 mm [1-1/2"] under thumb pressure for a 1.5 m [5 ft] cable length (equivalent ratio for other cable lengths). Adjust the clearance at cable strap/spacer piece restraints to not exceed 6 mm [1/4"].
 - .18 Provide transverse and axial restraints as close as practical to a vertical bend.
 - .19 At steel trusses, connect to top chords and follow truss manufacturer's instructions.

2.6 Vibration Isolation

.1 GENERAL

- .1 Provide vibration isolation on all motor driven equipment with motors of ½ hp and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than ½ hp, provide neoprene grommets at the support points.
- .2 Provide a balanced set of isolators for each piece of equipment. Select isolators in accordance with equipment weight distribution to allow for no less than 80% of

the static deflection specified. A minimum of four isolators are required, unless specified otherwise. Number and colour code each isolator to show location. Mark code number and colour on shop drawings, on each isolator and on each base to ensure proper placement. Clearly mark all isolators to show undeflected height, and static deflection.

- .3 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness for elastomers and do not exceed 60 durometer.
- .4 Use ductile materials in all vibration and seismic restraint equipment.
- .5 Coordinate with other sections for flexible mounting of piping connected to isolated equipment and for flexible connections of all ductwork connected to isolated fans and plenums.
- .6 Coordinate with division 16 for the provision of looped flexible conduit connections to isolated motors.
- .2 ISOLATORS - TYPE 4, HANGER MOUNTS
 - .1 Spring hangers, c/w 6 mm [1/4"] thick sound pads sized for 1.3 mm [.05"] minimum deflection, or neoprene hangers.
 - .2 A neoprene element alone, without a hanger box, is acceptable provided no short circuiting occurs.
 - .3 Standard of acceptance:
 - .1 Mason HD, HS, Vibron series VH.

2.7 Thermal and Acoustic Insulation

- .1 GENERAL
 - .1 As applicable, use the latest edition of the "BC Insulation Contractors Association (BCICA) standards manual" as a reference standard if sufficient detail/information is not specified herein.
 - .2 Flame spread ratings and smoke developed classifications shall be as required by the 1985 national building code and NFPA 90A-1985. Generally the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50.
- .2 EXTERNAL FLEXIBLE INSULATION WITH VAPOUR BARRIER
 - .1 Duct insulation to be applied to all relocated, revised and new ductwork.
 - .2 Provide 38 mm [1-1/2"] external flexible glass fibre insulation with integral vapour barrier as follows: all air supply ducts (downstream from air valves); all air conditioning unit supply ducts (downstream from the ac unit).
 - .3 Acceptable Manufacturers: Certainteed STP Ductwrap #75, Fiberglas AF300 (type II) RFFRK, Knauf FSK Ductwrap, Manson Alley-Wrap FSK, Manville Micro Litefsk.
- .3 ACOUSTIC DUCT LINER
 - .1 Flexible duct liner
 - .2 Internal flexible glass fibre acoustical insulation with sealer coating on one face.
 - .3 Minimum density - 24 kg/cu.m. [1.5 lbs/cu. Ft.].
 - .4 Thermal conductivity at 24 deg.c. - 0.040 w/m/deg.c.
 - .5 Acceptable Manufacturers: Certainteed #150, Certainteed Manson (CTM), Akousti-Liner, Knauf Duct Liner M, Schuller Linacoustic, Schuller Permacote.
- .4 PREFORMED PIPE COVERING
 - .1 Glass fibre preformed pipe insulation:

- .1 Glass fibre preformed pipe insulation (tested ASTM C-411-61) complete with integral reinforced vinyl foil laminated vapour barrier jacket (thermal conductivity at 24°C - 0.040 w/m/deg.c.)
- .2 Acceptable Products: Knauf, ASI, Fibreglas ASI, Manville Micro-Lok AP.
- .2 Refrigerant pipe insulation:
 - .1 Refrigerant pipe insulation shall comply with the City of Vancouver standard for energy conservation (ASHRAE 90.1).
 - .2 Insulation shall be installed in accordance with BCICA standard.
 - .3 Plastic jacket to be applied to all insulation exposed to outdoors. Jacket material to be suitable for outdoor applications.
- .5 Plumbing pipes, fire suppression pipes, fittings, valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Domestic cold water system including meter body.
 - .2 Domestic hot water supply and recirculation piping.
 - .3 Domestic tempered water supply and recirculation piping.
 - .4 Underside of drain bodies, rainwater leaders, storm drainage piping and fittings for the entire system.
 - .5 All drains, lines, stacks in unheated areas (insulation shall cover heat tracing cables).
 - .6 Water valves, flanges, PRV's, strainers, check valves.
- .6 Pipe Insulation Thickness Table - mm [ins]

Service	NOMINAL PIPE SIZE (NPS)					
	Design Operating Temperature	Runouts 2 and less (note 1)	1 and less	1 1/4 to 2	2 1/2 to 4	5 and larger
Refrigerant Suction and Hot Gas	5°C [40°F] or lower	25 [1]	40 [1.5]	40 [1.5]	40 [1.5]	40 [1.5]
Condensate (gravity)	100°C [212°F]	25 [1]	40 [1.5]	40 [1.5]	50 [2]	50 [2]
Condensate (pumped)	80°C [180°F]	25 [1]	25 [1]	25 [1]	40 [1.5]	40 [1.5]
Continuous C.W. Drainage	5 °C [40 °F]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Domestic Cold Water	5°C [40°F]	25 [1]	25 [1]	25 [1]	25 [1]	25 [1]
Domestic Hot & Tempered Water Supply and Recirculation	40-70 °C [105-160°F]	25 [1]	25 [1]	25 [1]	40 [1.5]	40 [1.5]

Note 1: Runouts to individual terminal units not to exceed 3.7 m [12 ft] in length.

Note 2: All piping forming part of the HVAC system or plumbing domestic hot water or domestic hot water recirculation piping, and located outside the building envelope (including piping located within unheated areas of the building such as underground parking levels) shall be insulated for the level specified in the Table for steam piping at pressures 334 kPa [121 psig] and greater.

.7 ACCESSORIES

- .1 Firestop materials:
 - .1 Firestopping and smoke seal systems: asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC CAN-S115-M85, or ULI 1479 and ASTM 814, and not to exceed opening sizes for which they are intended.
 - .2 Fire resistance rating of installed firestopping assembly shall be not less than the fire resistance rating of surrounding floor and wall assembly.
 - .3 Acceptable Products: Dow Corning FS2000 Silicone, Hilti Firestop CS2400, Tremco Fyre-Sil, 3M CP25WB.
- .2 Adhesives:
 - .1 Flexible elastomeric and flexible closed cell insulation adhesive: Armstrong 520, Therma-Cel 1590, Rubatexr-373, Zipcoat 8A.
- .3 Coatings:
 - .1 Flexible elastomeric and flexible closed cell insulation finish coating: Armstrong, Bakelite 120-13, Rubatex, Zipcoat.
- .8 SCOPE OF PIPING INSULATION
 - .1 Heating water piping, chilled water piping, domestic hot and cold water piping, fittings and valves:
 - .1 Insulate and vapour seal the following fittings:
 - .1 Elbows, tees, reducers.
 - .2 Valves, (bodies and bonnets) except check valve covers.
 - .3 Strainers.
 - .4 Flanges.
 - .5 Unions.

2.8 Piping

- .1 STEEL PIPE: TO ASTM A53 GRADE B AS FOLLOWS:
 - .1 To NPS 10, Schedule 40.
 - .2 For the following systems:
 - .1 Relief valve vents
- .2 COPPER PIPE: TO ASTM B88M-86, TYPE K, OR L HARD DRAWN COPPER TUBING.
 - .1 Type I, hard drawn:
 - .1 Domestic hot and cold water.
 - .2 Pressure drains (to nps 2).
 - .3 Domestic hot water preheat.
- .3 PIPE JOINTS - STEEL PIPING
 - .1 NPS 2 and under: screwed fittings, except where otherwise noted, with teflon tape or pulverized lead paste.
- .4 PIPE FITTINGS, SCREWED, FLANGED OR WELDED:
 - .1 Cast iron screwed fittings: class 125 to ANSI B16.3.
 - .2 Unions, malleable iron ground joint type: class 150 to ANSI B16.3.
- .5 GATE VALVES - NPS 2 AND UNDER, SCREWED:
 - .1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.
 - .2 Acceptable Products: Class 125 [860 kpa] - Crane 428, Grinnell 3010, Jenkins 810, Kitz 24, Newman Hattersley 607, Nibco T-111, Toyo 293.
- .6 GATE VALVES - NPS 2 AND UNDER, SOLDERED:
 - .1 Bronze body, rising stem, solid wedge disc, screwed bonnet.

- .2 Acceptable Products: Class 200 w.o.g. [1380 kpa] - Crane 1334, Grinnell 3080SJ, Jenkins 813, Kitz 44, Newman Hattersley 607C, Nibco S-134, Toyo 299.
- .7 **BALANCE FITTINGS (SCREWED CONNECTIONS) - NPS 1¼ AND UNDER:**
 - .1 Bronze body and bronze trim, rising stem, renewable composition disc, globe type with memory stop, lockshield, male union connection, angle and straight type.
 - .2 Acceptable Products: Class 100 [690 kpa] - Dahl 13000-M series, Toyo 250 or 251.
- .8 **GLOBE VALVES**
 - .1 NPS 2 and under, screwed:
 - .1 Bronze body, rising stem, solid wedge disc, union or screwed bonnet.
 - .2 Acceptable Products: Class 125 [860 kpa] - Crane 428, Grinnell 3010, Jenkins 810, Kitz 24, Newman Hattersley 607, Nibco T-111, Toyo 293.
 - .2 NPS 2 and under, soldered:
 - .1 Bronze body, rising stem, solid wedge disc, screwed bonnet.
 - .2 Acceptable Products: class 200 w.o.g. [1380 kpa] - Crane 1334, Grinnell 3080SJ, Jenkins 813, Kitz 44, Newman Hattersley 607C, Nibco S-134, Toyo 299.
- .9 **HANGER SPACING**
 - .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
 - .1 Plumbing piping: most stringent requirements of BC Plumbing code, provincial code, or authority having jurisdiction.
 - .2 Fire protection: to applicable fire code; toggle hangers are unacceptable.
 - .3 For gas piping refer to gas code CAN/CGA-B149.1.
 - .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
 - .5 Within 300 mm [12"] of each horizontal elbow.
 - .2 Maximum hanger spacing table.

Pipe Size: NPS	Rod Diameter mm [Ins]	Maximum Spacing Steel Pipe m [ft]	Maximum Spacing Copper Pipe M [ft]
½	10 [3/8]	1.8 [6]	1.5 [5]
¾, 1	10 [3/8]	2.4 [8]	1.8 [6]
1¼, 1½	10 [3/8]	3.0 [10]	1.8 [6]
2	10 [3/8]	3.0 [10]	3.0 [10]
2½, 3, 4	12 [1/2]	3.0 [10]	3.0 [10]
5, 6, 8	16 [5/8]	3.0 [10]	
10, 12	22 [7/8]	3.0 [10]	

2.9 Ductwork

- .1 **GENERAL**
 - .1 The construction and installation of ductwork shall be in accordance with the following referenced SMACNA manuals and ASHRAE handbooks.

- .1 SMACNA - HVAC Duct Construction Standards, 1985.
 - .2 SMACNA - HVAC Air Duct Leakage Test Manual, 1985.
 - .3 ASHRAE - handbook - equipment volume.
- .2 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.
- .2 GALVANIZED STEEL
 - .1 Galvanized steel shall have a 380 g/sq.m. [1-1/4 oz/sq.ft] galvanizing coat both sides to ASTM A525 G90.
- .3 DUCTWORK - ALUMINUM
 - .1 The following ductwork shall be fabricated from aluminum:
 - .1 Exhaust ductwork from showers/baths, to the extent noted on the drawings.
 - .2 Low pressure aluminum ductwork shall be constructed in accordance with clause 2.2 "ductwork - 500 pa [2"] static pressure".
 - .3 For round and rectangular aluminum ductwork, use four gauges heavier than that scheduled in table 1-5 or tables 1-14, 1-15, 1-16 of the SMACNA duct standards for galvanized ductwork.
 - .4 Aluminum shall be utility grade.
 - .5 Support aluminum ductwork using aluminum straps, cadmium plated threaded rods, aluminum flat bar or aluminum angle hangers. Support shall be similar to that specified for galvanized iron ductwork.
- .4 DUCTWORK PRESSURES
 - .1 Provide ductwork fabricated from galvanized steel for the static pressure categories listed below.
 - .1 500 pa [2" w.g.] static pressure: all supply ductwork downstream from mixing boxes/air valves to terminal air outlets; all return air ductwork.
 - .2 750 pa [3" w.g.] static pressure: all supply ductwork downstream from smoke dampers (leaving duct shafts or leaving mechanical room wall) up to the upstream connections to mixing boxes/air valves.
 - .2 Ductwork shall be constructed, reinforced, sealed and installed to withstand 1½ times the working static pressure.
- .5 DUCTWORK CLEANING
 - .1 This contractor shall be responsible for and ensure that all ductwork, installed under this contract is internally clean, when handed over to the owner.
 - .2 All ductwork shall be wiped clean of all oil and other surface films with suitable solvent prior to installation.
 - .3 Seal all openings at the end of each day and at such other time as site conditions dictate.
 - .4 Other openings to be covered with 0.15 mm [6 mils] thick poly sheet taped so as to be air tight.
 - .5 Where connecting to existing ductwork, clean re-used ductwork upstream for minimum 900 mm length.

- .6 Spot checks will be made by the consultant during the cleaning process to verify that the required standard is being met. When substantial performance is claimed, final spot checks will be made to verify that the ducts are generally clean. If any ducts are found to be unclean, then they shall be recleaned.

2.10 Duct Accessories

.1 BALANCING DAMPERS

- .1 Construction in accordance with SMACNA duct standards - figs. 2-14 and 2-15.
- .2 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing.
- .3 Provide balancing dampers at each run out to a grille or diffuser.
- .4 On all round ductwork and on externally insulated rectangular ductwork, provide sheet metal bridge to raise quadrant type operators above the insulation thickness. Provide an open end bearing where bridges are used. Bridges on uninsulated round ducts shall be at least 25 mm [1"] high.

.2 DUCT CONNECTORS - VIBRATION ISOLATION

- .1 Provide flexible duct connections to provide vibration isolation at all duct and plenum connections to fan and air handling units. See figure 2-19 SMACNA duct standards.
- .2 Minimum requirements:
 - .1 Pre-assembled 75 mm [3"] minimum long flexible connection with 75 mm [3"] long 0.62 mm [24 ga] galvanized steel duct connectors on each side of the flexible connection. Flexible connector - fiber glass fabric with elastomer coating.
- .3 Standard of Acceptance: Duro Dyne "Durolon", Dynair "Hypalon", Ventfabrics "Ventlon".

.3 DUCT ACCESS

- .1 Provide access panels as follows:
 - .1 Every 12 m [40 ft] on all ductwork.
 - .2 At or to one side of other equipment in duct, e.g. balance dampers serving multiple outlets/inlets; control sensors.
- .2 Products: Nailor Hart, Ventlok, 25 mm [1"] thick insulation.

.4 ACCESS DOORS

- .1 Supply flush mounted access doors, for installation by building trades in furred ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, and where specifically indicated.
- .2 Unless otherwise noted, access doors shall be minimum: 450mmx450mm [18"x18"] for body entry; 300mmx300mm [12"x12"] for hand entry; 200mmx200mm [8"x8"] for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary.
- .3 Locate access doors so that all concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in panelled, feature or special finish walls, without prior approval of the consultant.
- .4 Minimum requirements:

- .1 180 degree door swing, mitred rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, all steel prime coated.
- .2 Drywall construction: 16 gauge for 400 mm [16"] x 400 mm [16"] and smaller, 14 gauge for 450 mm [18"] x 450 mm [18"] and larger bonderized steel face of wall type with exposed flange. Acceptable Product: Acudor UF-5000.
- .5 Standard of Acceptance : Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.
- .5 DUCTWORK - FLEXIBLE - PLAIN
 - .1 Provide factory fabricated plain, flexible air ductwork for connections to air terminals, and connections to downstream side of air valves. (all connections upstream of air valves and mixing boxes to be rigid construction).
 - .2 Suitable for up to 2500 pa [10" w.g.] positive static pressure and 250 pa [1" w.g.] negative static pressure.
 - .3 UL or ULC labelled, class 1, duct connector. Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.
 - .4 Installed lengths shall be limited to 6 times duct diameter but not longer than 900 mm [3 ft].
 - .5 Connect to ductwork and diffusers with stainless steel worm drive clamps or panduit adjustable clamps or thermaflex duct strap applied over two wraps of duct tape. Use stainless steel clamps on connections to fire dampers.
 - .6 Minimum centreline radius of flexible ductwork bends shall be 1.5 times the duct diameter, alternatively, sheet metal elbows may be used at branch takeoffs and boot/diffuser connections.
 - .7 Support clear of ceiling assembly, light fixtures and hot surfaces with 25 mm x 0.76 mm [1"x22 ga] galvanized steel straps at a maximum of 1.5 m [5'-0"]. Straps shall completely encircle duct.
 - .8 Standard of Acceptance: Flexmaster Fab4, Thermaflex SLP10,

2.11 Air Distribution Equipment

- .1 AIR TERMINALS
 - .1 All air terminals must be site checked for compatibility with ceiling types prior to ordering. Submit shop drawings. Refer to architectural reflected ceiling plans for exact air terminal locations.
 - .2 All ceiling mounted air terminals shall be provided with means for attachment of two (2) 12 ASWG seismic security wires at opposite corners of each air terminal.
 - .3 Provide concealed baffles, where necessary, to direct air away from walls, columns or other obstructions within the radius of air terminal operation. Provide full perimeter sponge rubber gaskets.
 - .4 Paint ductwork behind grilles with matte black paint where duct or insulation surfaces are visible.
 - .5 Provide discharge attenuator for all units.
 - .6 Acceptable Manufacturers: E.H. Price, Titus.
- .2 AIR VALVES - GENERAL
 - .1 Size as shown on drawings, max. Air volumes as shown on drawings.
 - .2 Provide controls valves and actuators to minimum base building standard.
 - .3 Number shall be painted on black on two sides and the bottom, Franklin Gothic 50 mm [2"] high. Confirm number prior to painting.

- .4 Provide discharge attenuator for all units.
- .5 Acceptable Manufacturers: E.H. Price, Titus.
- .3 FANS - GENERAL
 - .1 Submit fan sound power levels with shop drawings, measured to AMCA 300 and calculated to AMCA 301, or other data acceptable to the consultant. Provide test data if requested. Fans exceeding design levels may be rejected.
 - .2 Design is based on fan sound power levels, discharge only, predicted by the ASHRAE Handbook.
 - .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.
 - .4 Dynamically balance fans to 1.5mm/s vibration amplitude, maximum measured on bearing housings. Provide fan shafts with critical speed at least 1.5 times operational speed.
 - .5 Ratings: based on tests performed in accordance with AMCA 210, and ASHRAE 51. Units shall bear AMCA certified rating seal.
 - .6 Refer to drawings for motor position, rotation and discharge arrangements.

2.12 Controls

- .1 GENERAL
 - .1 Relocate existing control devices as indicated.
 - .2 Where existing devices are re-used, verify operation and re-calibrate as required.
 - .3 Verify correct operation of controlled devices including existing air valve actuators, control valves, etc. Within the area of renovation.
 - .4 Control valves and actuators to be compatible with base building standard unless noted otherwise. New control valve operation to be compatible with existing.
 - .5 Report any existing control device which need replacement. Replacement will be by building management or via change order, at the discretion of the owner.
 - .6 Refer to Section 2.11 for mechanical equipment controls.
- .2 ROOM THERMOSTATS
 - .1 Minimum requirements
 - .1 Adjustable sensitivity and set point.
 - .2 New thermostats to meet minimum base building standard.

3 Execution

3.1 Concealment

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

3.2 Accessibility

- .1 Install all work so as to be readily accessible for adjustment, operation and maintenance. Furnish access doors where required in building surfaces for installation by building trades. Refer to item "Access Doors."

3.3 Piping Expansion

- .1 Install piping with all necessary changes of direction, expansion loops, anchors and guides so that expansion and contraction will not overstress the piping and equipment piping connections.
- .2 Expansion loops shall be of all welded construction with long radius elbows; cold sprung 50% and located between anchors.
- .3 Anchors shall be fabricated from mild steel plate and structural steel angle and channel sections, in accordance with ANSI B.31.

3.4 Protection of Work

- .1 Protect equipment and materials, stored or in place, from the weather, moisture, dust and physical damage.
- .2 Mask machined surfaces. Secure covers over equipment openings and open ends of piping, ductwork and conduits, as installation work progresses.
- .3 Equipment having operating parts, bearings or machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.
- .4 Refinish damaged or marred factory finish.
- .5 Air systems to have air filters installed before fans are operated. Install new air filters before system acceptance.

3.5 Cutting, Patching, Digging, Canning, and Coring

- .1 Lay out all cutting, patching, digging, canning and coring required to accommodate the mechanical services. Coordinate with other Divisions.
- .2 Refer to structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls. Openings through structural members of the building shall not be made without the approval of the Consultant.
- .3 Be responsible for correct location and sizing of all openings required under Division 22 and 23, including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.
- .4 Verify the location of existing service runs and steel reinforcing within existing concrete floor and walls prior to core drilling and/or cutting. Repairs to existing services and structural components damaged as a result of core drilling and cutting is included in this section of the work.
- .5 Be responsible for all cutting, patching, digging, canning and coring required to accommodate the mechanical services.
- .6 All openings shall be core drilled or diamond saw cut.

3.6 Fastening to Building Structure

- .1 General:
 - .1 Do not use inserts in base material with a compressive strength less than 13.79 MPa [2000 psi] [refer to structural drawings].
 - .2 All inserts supporting piping shall have a factor of safety of 5. All other inserts shall have a factor of safety of 4.
- .2 Types:
 - .1 Cast-in-place type:
 - .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.
 - .2 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 200 mm [8"] pipe size.

- .3 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 200 mm [8"] pipe size.
- .4 Screw concrete insert, Grinnell Fig. 152 for up to 300 mm [12"] pipe size.
- .2 Drilled, mechanical expansion type:
 - .1 Hilti HSL or UCAN LHL heavy duty anchor for use in concrete with compressive strength not less than 19.6 MPa [2840 psi].
 - .2 Hilti Kwik-Bolt or UCAN WED stud anchor for concrete. (Do not use in seismic restraint applications).
 - .3 Hilti HDI or UCAN IPA drop-in anchor for concrete.
 - .4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.
 - .5 Hilti ZBP or UCAN Zamac pin bolt (light duty) for concrete and masonry.
- .3 Drilled, adhesive type:
 - .1 Hilti HVA or UCAN Adhesive Anchor consisting of anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.
 - .2 Hilti HY150 consisting of anchor rod with a 2 part adhesive system.
 - .3 For use in concrete housekeeping bases (in vertical downward position) where the distance to the edge of the concrete base could cause weakness if a mechanical expansion type anchor were used.
 - .4 Rod assemblies shall extend a minimum of 50 mm [2"] into the concrete slab below the housekeeping bases.
- .3 Note:
 - .1 All drilling for inserts shall be performed using the appropriate tool specifically designed for the particular insert. The diameter and depth of each drilled hole shall be to the exact dimensions as specified by the insert manufacturer.
 - .2 Refer to manufacturer's recommendations for tightening torques to be applied to inserts.
 - .3 Where specifically called for, drills shall include a dust vacuum system, Hilti SAV Dust Vacuum System.

3.7 Service Penetrations in Rated Fire Separations

- .1 All piping, tubing, ducts, wiring, conduits, etc. passing through rated fire separations shall be smoke and fire proofed with ULC approved materials in accordance with CAN4-S115-M85 and ASTM E814 standards and which meet the requirements of the Building code in effect. This includes new services, which pass through existing rated separations, and also all existing services, which pass through a new rated separation or existing separations whose rating has been upgraded.
- .2 Fire resistance rating of installed firestopping assembly shall not be less than fire resistance rating of surrounding assembly indicated on Architectural drawings.
- .3 All smoke and fire stopping shall be installed by a qualified Contractor who shall submit a letter certifying that all work is complete and in accordance with this specification.
- .4 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions in formed, sleeved or cored penetrations.

3.8 Service Penetrations in Non-Rated Separations

- .1 All piping, tubing, ducts, wiring, conduits, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent the passage of smoke and/or transmission of

sound. Refer to "pipe sleeve" clause in this section for packing and sealing of pipe sleeves.

3.9 Pipe Sleeves

- .1 Provide pipe sleeves for all piping passing through rated walls and floors. Sleeves to be concentric with pipe.
- .2 Pipes and ducts passing through fire rated separations that have no fire resistance (non-rated separations) do not require a sleeve, but the insulation at the separation should be wrapped with 0.61 [24 ga] thick galvanized sheet steel band to which to apply the flexible caulking compound to.
- .3 Pipe sleeves for floors and interior walls shall be minimum 0.61 [24 ga] thick galvanized sheet steel with lock seam joints.
- .4 Pipe sleeves for perimeter walls and foundation walls shall be cast iron sleeve or Schedule 40 steel pipe with annular fin continuously welded at midpoint and protruding 150 mm [6"] beyond sleeve diameter. Annular fin shall be embedded into centre of wall.
- .5 Pipe sleeves for wet or washdown floor areas such as washrooms, janitor's rooms, laboratories and mechanical equipment rooms shall be Schedule 40 steel pipe.
- .6 Except as otherwise noted pipe sleeves are not required for holes formed or cored in interior concrete walls or floors.
- .7 Pipe sleeves shall extend 50 mm [2"] above floors in unfinished areas and wet areas and 6 mm [1/4"] above floors in finished areas.
- .8 Pipe sleeves shall extend 25 mm [1"] on each side of walls in unfinished areas and 6 mm [1/4"] in finished areas.
- .9 Pipe sleeves shall extend 25mm [1"] beyond exterior face of building. Caulk with flexible caulking compound.
- .10 Sleeve Size: 12 mm [1/2"] clearance all around, between sleeve and pipe or between sleeve and pipe insulation.
- .11 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.
- .12 Packing of Sleeves:
 - .1 Where sleeves pass through foundation walls and perimeter walls the space between sleeve and pipe or between sleeve and pipe insulation shall be caulked with waterproof fire retardant non-hardening mastic.
 - .2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.10 Escutcheons and Plates

- .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.
- .2 Plates shall be stamped steel, split type, chrome plated, or stainless steel, concealed hinge, complete with springs, suitable for external dimensions of piping/insulation. Secure to pipe or finished surface. For all pipes passing through suspended ceilings and uninsulated piping passing through walls. Outside diameter shall cover opening or sleeve.
- .3 Where pipe sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.
- .4 Do not install escutcheons and plates in concealed locations.

3.11 Equipment Supports

- .1 Provide stands and supports for equipment and materials supplied.
- .2 Lay out concrete bases and curbs required under Divisions 22 and 23. Coordinate with Division 3. All concrete work is under Division 3.

- .3 Concrete bases shall be a minimum of 100 mm [4"] thick, or as noted and shall project at least 150 mm [6"] outside the bedplate, unless otherwise directed. Bases and curbs shall be keyed to the floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases at 45 degrees.
- .4 Equipment with bedplates shall have metal wedges placed under the edges of the bedplates to raise them 25 [1"] above the base after levelling. The wedges shall be left permanently in place. Fill the space between the bedplate and the base with non-shrink grout - Embeco or In-Pakt.
- .5 Construct equipment supports of structural steel or steel pipe. Securely brace. Employ only welded construction. Bolt mounting plates to the structure.
- .6 Support ceiling hung equipment with rod hangers and/or structural steel.

3.12 Equipment Restraint

- .1 It is the entire responsibility of equipment manufacturers to design their equipment so that the strength and anchorage of internal components of the equipment exceeds the force level used to restrain and anchor the unit itself to the supporting structure.

3.13 Equipment Installation

- .1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to piping and duct systems and without interfering with building structure or other equipment.
- .2 Provide means of access for servicing equipment including permanently lubricated bearings.
- .3 Pipe equipment drains to floor drains.
- .4 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

3.14 Anchor Bolts and Templates

- .1 Supply anchor bolts and templates for installation by other divisions.

3.15 Miscellaneous Metal

- .1 Be responsible for all miscellaneous steel work relative to Division 22 and 23 of the Specifications, including but not limited to:
 - .1 Support of equipment, including cooling tower.
 - .2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, heat exchangers, hot water storage tanks, expansion tanks, fans and mechanical equipment.
 - .3 Earthquake restraint devices/
 - .4 Access platforms, ladders, and catwalks.
 - .5 Pipe anchor and/or support posts.
 - .6 Ceiling ring bolts - secure to structure or steel supports.
 - .7 All steel work shall be prime and undercoat painted ready for finish under Division 9.

3.16 Flashing

- .1 Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors, and roofs.
- .2 Flash, vent and soil pipes projecting 75 mm [3"] minimum above finished roof surface with lead worked 25 mm [1"] minimum into hub, 200 mm [8"] minimum clear on side with minimum 600 x 600 mm [24" x 24"] sheet size. For pipes through outside walls turn flange back into wall and caulk.

- .3 Flash floor drains over finished areas with lead 250 mm [10"] clear on sides with minimum 900 x 900 mm [36" x 36"] sheet size. Fasten flashing to drain clamp device.
- .4 Provide curbs for mechanical roof installations 200 mm [8"] minimum high above roof insulation. Flash and counterflash with galvanized steel, soldered and made waterproofed.
- .5 Provide continuous lead or neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm [6"] into walls or to top of curbs and caulk into joints.

3.17 Dielectric Couplings

- .1 On all "OPEN" systems provide wherever pipes of dissimilar metals are joined.
- .2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.
- .3 Provide felt or rubber gaskets to prevent dissimilar metals contact.
- .4 Standard of Acceptance: Capital, Walter Vallet, EPCO.

3.18 Lubrication of Equipment

- .1 Lubricate all new equipment prior to being operated, except sealed bearings, which shall be checked.
- .2 Use the lubricant recommended by the manufacturer for the service for which the equipment is specified.
- .3 Extend lubricating connections and sight glasses to the outside of housings, where lubricating positions are not readily accessible.
- .4 Submit a check list, showing that all operated equipment has been lubricated prior to and during any temporary heating period and the demonstration and instruction period.

3.19 Painting

- .1 Clean exposed bare metal surfaces supplied under Division 22 and 23 removing all dirt, dust, grease and millscale. Apply at least one coat of corrosion resistant primer paint to all supports and equipment fabricated from ferrous metal.
- .2 Paint all pipe hangers and exposed sleeves, in exposed areas, with a rust inhibiting primer, as they are installed.
- .3 Repaint all marred factory finished equipment supplied under Division 22 and 23 which is not scheduled to be repainted, to match the original factory finish.
- .4 Natural gas and fire protection piping shall be painted for identification purposes over their entire lengths throughout all exposed areas and in the mechanical room(s) as follows:
 - .1 Gas: Yellow C.G.S.B. 505-101
 - .2 Fire: Red C.G.S.B. 509-102
- .5 Coordinate with Division 9.
- .6 Painting of all equipment and materials, supplied under Division 22 and 23, installed in mechanical equipment areas and inside finished areas of the building or exposed outside the building, is included under Division 9 of the Specification.
- .7 Painting by Division 9 shall be in accordance with the following Colour Schedule for Mechanical Equipment Areas:

Item	Primer (Note **)	Colour Finish
Ductwork, Plenums and Miscellaneous Steel		
• not galvanized	1. Damp-proof Red 2. Zinc Chromate	Grey
• galvanized	Clear blue undercoat	White (2 coats)
• plenum access doors and 200 mm around doors	Clear blue undercoat	Grey
Exposed Misc. Metal (supplied under this contract)	1. Damp-proof Red 2. Zinc Chromate	To be determined on site
Fan Casings and Bases	1. Damp-proof Red 2. Zinc Chromate	Grey
Guards – Belt and Coupling	1. Damp-proof Red 2. Zinc Chromate	To match equipment
Insulation Covering (on piping, tanks, heat exchangers, breeching, etc.)	White Primer	White
Motors (electric)		To match associated equipment
Piping (uninsulated)	Red Primer	White

Note ** 1. denotes first primer coat and 2. denotes second primer coat.

3.20 Equipment Protection and Clean-Up

- .1 Protect equipment and material in storage, on site and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
- .2 All mechanical equipment stored on site shall be kept in a dry, heated and ventilated storage area.
- .3 Thoroughly clean piping, ducts and equipment of dirt, cuttings, and other foreign material.
- .4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .5 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated and building is not at a clean condition.

3.21 Start-Up

- .1 Before starting the plant, provide a certificate stating that the plant is ready for start-up and the following conditions have been met.
 - .1 All safety controls installed and fully operational.
 - .2 Qualified personnel available to operate the plant.
 - .3 Permanent electrical connections made to all equipment.
 - .4 All air filters installed.
 - .5 Pump and fan drives properly aligned by a journeyman millwright.
 - .6 All mechanical equipment rooms, including plenums, vacuum cleaned.

3.22 Demonstration and Instruction to Operating Staff

- .1 Provide certified personnel to demonstrate plant operation and to instruct operating staff on operation of mechanical equipment. Provide maintenance specialist personnel to instruct operating staff on maintenance and adjustment of mechanical equipment and any changes or modification in equipment made under terms of guarantee.
- .2 The demonstration shall include:
 - .1 Operation and sequencing of all automatic control dampers and automatic temperature control devices.

- .2 Operation of smoke venting and pressurization systems including smoke dampers and fire fighters control panel.
- .3 Operability of randomly selected fire dampers.
- .4 Operation and maintenance requirements of all air, gas and water systems and equipment under each mode of operation including:
 - .1 Plumbing Systems.
 - .2 Gas and fuel systems.
 - .3 Fans.
 - .4 Coils.
- .3 Provide instruction during regular work hours prior to acceptance and turn-over to operating staff for regular operation.
- .4 Use Operating and Maintenance manuals for instruction purposes.
- .5 Submit the proposed instructional agenda for approval.
- .6 Finalize demonstration and instructions by obtaining a signed statement from the Owner that the demonstration and instructions have been given satisfactorily.

END OF SECTION