
PART 1 - GENERAL

1.1 Protection of Openings

- .1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

1.2 Painting

- .1 To Section 09 91 23 - Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.3 Spare Parts

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:
 - .1 One set of packing for each pump.
 - .2 One casing joint gasket for each size pump.
 - .3 One glass for each gauge glass.
 - .4 One filter cartridge or set of filter media for each filter or filter bank in addition to construction set and final operating set.
 - .5 One set of V-belts for each piece of machinery.

1.4 Special Tools

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.5 Demonstration and
Operating and
Maintenance Instructions

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Where specified elsewhere in Divisions 21, 22, 23, and 25 manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built/record drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, the Departmental Representative may record these demonstrations on video tape for future reference.

1.6 Closeout Submittals

- .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with Departmental Representative before final inspection.
- .3 Operation data to include:
 - .1 Control schematics for each system including environmental controls.
 - .2 Description of each system and its controls.
 - .3 Description of operation of each system at various loads together

- with reset schedules and seasonal variances.
- .4 Operation instruction for each system and each component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .8 Legend of above ceiling identifiers.

- .4 Maintenance data shall include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.

- .5 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing (TAB) of Mechanical Systems.
 - .5 Cross connection and backflow device inspection report for each installed backflow preventer.

- .6 Approvals:
 - .1 Submit three (3) copies of draft Operation and Maintenance Manual to Consultant for approval. Submission of individual data will not be accepted unless so directed by the Departmental Representative.
 - .2 Make changes as required and re-submit as directed by the Departmental Representative.

- .7 Additional data:
 - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.
 - .2 MSDS for all hazardous material installed and left stored on site or with the Departmental Representative.
 - .3 Analysis of hydronic systems water after cleaning and treatment of piping.

1.7 Shop Drawings
and Product Data

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances. e.g. access door swing spaces.
 - .3 Wiring diagrams showing field wiring connections and field wiring between related components.
- .3 Shop drawings and product data shall be accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.
- .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures. Use the "Shop Drawing Submittal Form" included in this specification section. Identify section and paragraph number.

- .5 Provide one (1) electronic (PDF) copy of shop drawings for the following items:
 - .1 General:
 - .1 Firestopping Materials (as per Section 07 84 00).
 - .2 Access Doors (walls/ceilings/floors).
 - .3 Drain Valves.
 - .4 Vibration Isolation (bases, pads, mounts, hangers, springs).
 - .2 Insulation:
 - .1 Pipe Insulation.
 - .2 Duct Insulation.
 - .3 Equipment Insulation.
 - .4 Insulation Covers.
 - .3 Plumbing:
 - .1 Pipe hangers, bases and supports.
 - .2 Thermometers.
 - .3 Pressure gauges.
 - .4 Valves (all types) serving DCW, DHW, DHWR.
 - .5 Check valves.
 - .6 Pressure reducing valves.
 - .7 Temperature and pressure relief valves.
 - .8 Floor drains (all types).
 - .9 Cleanouts (all types).
 - .10 Non-freeze wall hydrants.
 - .11 Water hammer arrestors.
 - .12 Backflow preventers.
 - .13 Vacuum breakers.
 - .14 Pressure relief valves.
 - .15 Water meters.
 - .16 Strainers.
 - .17 Tempering/mixing valves.
 - .18 Plumbing fixtures chair carriers. Fixtures, fittings and trim.
 - .19 Trap primer manifolds.
 - .20 Domestic hot water heater.
 - .4 Heating/Cooling Systems:
 - .1 Indoor Evaporator Heads.
 - .2 Outdoor Condensing Unit.
 - .3 Refrigerant Valves.
 - .5 Ventilation and Air Conditioning:
 - .1 Duct Sealant.
 - .2 Duct Tape.
 - .3 Flexible Ductwork.
 - .4 Flexible Duct Connections.

- .5 Duct Access Doors.
- .6 Balancing Dampers (single and multi-bladed).
- .7 Motorized Dampers and Actuators.
- .8 Backdraft Dampers.
- .9 Fire Dampers.
- .10 Ceiling and inline fans.
- .11 Filters and filter gauges.
- .12 Louvres.
- .13 Grilles, Registers, and Diffusers (all types).
- .14 Controls and Instrumentation.
- .15 Energy Recovery Ventilators.
- .16 Ductless split systems.
- .6 Fire Protection:
 - .1 Portable Fire Extinguishers (all types-see Section 10 44 20).

1.8 Cleaning

- .1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork, air handling units, and exhaust fans.
- .2 Clean the job site daily. The Contractor shall allow for a minimum of one man to perform daily clean-up duty. If the site is not cleaned to the Departmental Representative's satisfaction, then the Departmental Representative shall decide for cleaning and charge the cost against the Contract.

1.9 As-Built Drawings

- .1 Site records:
 - .1 The Departmental Representative will provide one set of reproducible mechanical drawings. Provide one set of white prints as required for each phase of the work. The contractor shall mark thereon all changes as work progresses and as changes occur.
 - .2 On a (weekly) basis, transfer information to reproducible,

- revising reproducible to show all work as actually installed.
- .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection always.
- .2 As-built drawings:
- .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built/record drawings.
 - .2 Identify each drawing in lower right-hand corner in letters at least 13mm high as follows: - "AS BUILT/RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
 - .3 Submit to the Departmental Representative for approval and make corrections as directed.
 - .4 TAB to be performed using as-built drawings.
 - .5 Submit completed reproducible as-built/record drawings with each of the Operating and Maintenance Manuals.
 - .6 The Departmental Representative shall use the Contractor's marked up drawings to produce electronic copies of the As-Built/Record Drawings. Refer also to Section 01 78 00 Closeout Submittals.
- .3 Submit copies of as-built drawings for inclusion in final TAB report.

1.10 Definitions

- .1 The word "provided" shall mean "supply and install" unless otherwise indicated.
- .2 Provide new materials, equipment and plant of proven design and quality and of current models with published ratings for which replacement parts are readily available.
- .3 Conform to requirements of "General Conditions" and "Division 1".

1.11 Drawings
and Specifications

- .1 Not intended to show structural details or architectural features.
- .2 Except where dimensioned, indicates general mechanical layouts only. Do not scale.
- .3 The Contractor shall check the content of the drawings, specifications and dimensions, and before proceeding, report to the Departmental Representative any error or omission between mechanical or electrical and architectural plans.
- .4 These specifications are to be considered as an integral part of the drawings which accompany them, neither the drawings nor the specifications shall be used alone. Any item which is omitted in one, but which is reasonably implied in the other, shall be considered properly and sufficiently specified and must, therefore, be provided under the Contract. The decision of the Departmental Representative shall be final, if interpretation is required.
- .5 Misinterpretation of drawings and specifications shall not relieve the Contractor of responsibility.
- .6 All Contractors shall make themselves familiar with the overall intended operation of the mechanical systems prior to installation so that all necessary accessories such as dampers, vents, valves, controls, etc., can be installed during the normal progress of the work. Failure to do so will result in the Contractor's responsibility in providing such devices, at his expense when the need of such devices becomes apparent during start-up.

1.12 Site Visits

- .1 Before commencing work, visit site and verify that requirements of Plans and Specifications are consistent with site conditions.
- .2 Advise Departmental Representative, in writing, of any discrepancies or conflicts.
- .3 No allowance shall be made for failure to include items which a thorough investigation would have shown to be required.

1.13 Guarantees

- .1 This Contractor shall guarantee all his work free from defects for a period of one year, unless specifically noted otherwise, after final acceptance of such work by the Departmental Representative and shall make good all defects other than normal wear and tear during the life of the guarantee. This Contractor shall guarantee all work and equipment supplied by him to work quietly and satisfactorily and to accomplish the work for which it was installed during the life of the above guarantee. At any time during this period, he shall make any necessary changes and adjustments or replacements, to accomplish this at his own expense.
- .2 Submit manufacturers' written guarantees to the Departmental Representative for review.
- .3 Bind guarantees in hard cover report binder suitable for 216 mm x 279 mm sheets. Label cover "Guarantees" and show project name. Provide title sheet and table of contents.
- .4 Each guarantee shall include:
 - .1 Project name and address.

- .2 Guarantee period (commencement date shall be as date shown on Project Final Certificate of Completion unless otherwise indicated).
- .3 Clear and concise definition of what is guaranteed, and remedial action provided.
- .4 Signatures of Contractor and a company officer of the manufacturing firm.

1.14 Permits
and Regulations

- .1 All Contractors shall comply with all regulations of Authorities having jurisdiction, where applicable, including but not limited to the following:
 - Provincial Department of Labour
 - Provincial Fire Marshal
 - Municipal Plumbing Inspector
 - Provincial Board of Insurance Underwriters
 - Provincial Department of Health
- .2 The Contractor shall obtain and pay for any permits required by Local Codes and Regulations and arrange for inspections.
- .3 Any additional materials or labour required to conform to any of these rules and regulations will be furnished under the Contract with no additional cost to the Departmental Representative.

1.15 Reference Standards

- .1 Use following latest editions and amendments in effect on date of Tender call:

AABC	Associated Air Balance Council
ADC	Air Diffusion Council
AMCA	Air Moving and Conditioning Association
ARI	Air Conditioning and Refrigeration Institute

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CEMA	Canadian Electrical Manufacturers Association
CFUA	Canadian Fire Underwriters' Association
CGSB	Canadian Government Specification Board
CHVAC	Canadian Heating, Ventilation and Air Conditioning Code (NRC)
CSA	Canadian Standards Association
CUA	Canadian Underwriters' Association
HRA	Heating, Refrigeration and Air Conditioning Institute of Canada
NACE	National Association of Corrosion Engineers
NBC	National Building Code of Canada
NBFU	National Board of Fire Underwriters'
NBS	National Bureau of Standards
NFPA	National Fire Protection Association
NSC	National Standards of Canada
SMACNA	Sheet Metal and Air Conditioning Contractors National Association Inc.
TIMA	Thermal Insulation Manufacturers Association
UL	Underwriters' Laboratories
ULC	Underwriters' Laboratories of Canada

1.16 Co-Ordination

- .1 Co-ordinate work with other trades to avoid conflict.

- .2 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.
- .3 Co-ordinate location of duct drops, pipe drops and risers with trades erecting walls and ceilings to ensure that all pipes and ducts are concealed in walls or ceilings spaces. If space is not available in walls or ceilings, locate ducts and pipes so that they can be easily boxed in by the relevant trades. Where pipes are shown rising in concrete block walls, placement of the pipe shall be done in conjunction with the erection of the wall.

1.17 Cutting and Patching

- .1 Cutting and patching to be performed by each Contractor for penetrations less than or equal to 200mm dia. or 200mm x 200mm.
- .2 Make every effort to minimize cutting and patching and provide dimensions, locations and other data for bases, sleeves, boxes, etc., to be built in as construction proceeds. Set sleeves and make openings in concrete forms and masonry before placing concrete and masonry.

1.18 Excavation and Backfilling

- .1 Excavation and backfilling will be performed under Section 31 23 10. Supervision by this Contractor.

1.19 Tests

- .1 Notice of Tests: Give written notice for a minimum of four working days prior to date when tests will be made.
- .2 Prior Tests: Concealed or insulated work shall remain uncovered until completely tested and approved, but if construction schedule requires, arrange

for prior tests on parts of system as approved.

- .3 Acceptance Tests: Conduct in presence of the Consultant's representative or representative of the Authorities Having Jurisdiction.
- .4 Costs: Bear all costs in connection with tests conducted.
- .5 Certificates: Obtain acceptance certificates from Agencies having jurisdiction. Work is not considered complete until certificates have been delivered to the Departmental Representative.
- .6 Water Systems: Fill with water and hydraulically test at $1\frac{1}{2}$ times system operating pressure or at 689kPa, whichever is greatest. Unless otherwise noted maintain test pressures without loss for a four (4) hour period. Use valves to isolate equipment not rated for this pressure.
- .7 Test plumbing sanitary sewer, storm sewer and vent piping as required by National Building Code, National Plumbing Code of Canada, and Municipal Regulations.
- .8 Sanitary and vent piping shall be tested by sealing outlets and filling the system to the highest point with water. The water level shall remain constant for a minimum of two (2) hours.
- .9 Hammer test all welded joints.

1.20 Sleeves
and Escutcheons

- .1 Sleeves:
 - .1 Unless otherwise specified, supply pipe sleeves for all points where pipe passes through masonry or concrete walls or floors. Sleeve shall be supplied by the Mechanical

- Sub-Contractor and built-in by appropriate trade.
- .2 Where concrete walls or floors are core drilled to accommodate pipe, sleeves are not required except where indicated in paragraph 1.21.1.5 below.
 - .3 Unless otherwise specified, construct sleeve of galvanized sheet steel with lock seam joints of minimum 0.80mm.
 - .4 Use cast iron or galvanized steel pipe sleeves with perimeter fin continuously welded at mid point.
 - .1 Where sleeve extends above finished floor.
 - .2 Pipe penetrations through concrete foundation walls shall be sealed using proprietary pre-manufactured, water-tight seals.
 - .5 In washrooms and other wet areas where water from spills or leaks may penetrate the floor slab, extend sleeves 6.4mm above the finished floor. This does not apply to concrete slabs on grade. In all other areas, sleeves shall be flush with the finished floor.
- .2 Sizes:
- .1 Provide approximately 13mm clearance, all around, between sleeve and pipes or between sleeve and insulation.
 - .2 Unless otherwise specified, terminate sleeves flush with walls and ceilings.
 - .3 Sleeves shall be sized to accommodate the insulated pipe diameter.
 - .4 Through footings, use sleeves large enough to accommodate hub of cast iron soil pipe (where applicable).
 - .5 Where piping passes below footings, provide minimum all-round clearance of 50mm between piping and sleeves. Backfill up to underside of footing

with concrete of same strength as footing.

- .3 Unless otherwise indicated for pipes passing through roofs, use galvanized or cast-iron sleeves with caulking recess and flashing clamp device. Anchor sleeves in roof construction; caulk between sleeve recess and pipe; fasten roof flashing to clamp device; make watertight durable joint.
- .4 Caulking:
 - .1 Caulk sleeves below grade floors with oakum and lead between sleeve and pipe.
 - .2 Where sleeves pass through on grade concrete slab floors, caulk space between insulation and sleeve or between pipe and sleeve with dry oakum. Seal space at each end of sleeve with non-hardening mastic.
 - .3 Ensure no contact between copper tube or pipe and ferrous sleeve.
- .5 Escutcheons and Plates:
 - .1 Provide on pipes passing through finished walls, partition floors and ceilings.
 - .2 Use chrome or nickel-plated brass, either split or solid type, with set screws for ceiling or wall-mounted. For equipment room, use cast iron type.
 - .3 Inside diameter shall fit around finished pipe insulation or uninsulated pipe. Outside diameter shall cover sleeve.
 - .4 Where sleeve extends above finished floor, escutcheons or plates shall be bell shaped to cover the sleeve extension.
 - .5 Secure to pipe or sleeve but not to insulation.
- .6 Penetrations of Fire Separations:
 - .1 Where pipes or ducts pass through walls or floors which provide fire separations, seal around openings with ULC or cUL classified fire stop system. Material shall be

installed to manufacturers' recommendations by factory trained installers and shall provide a fire rating equal to that of the separation which has been penetrated.

- .2 Consultant reserves the opportunity for destructive testing of a sample of the installation to examine the thickness of sealant and installation of the backing material.
- .3 Provide shop drawings in accordance with specification Section 21 05 01 of Fire Stop system to be used. See also Section 07 84 00. Each trade Contractor shall be responsible for his/her own firestopping.

1.21 Di-Electric Unions

- .1 All connections between steel and copper or brass for pipe 50 mm and smaller shall be made of di-electric unions, except on all closed systems. On pipe 63 mm and larger, use flanged connections with non-metallic gasket and plastic sleeves for bolts.

1.22 Completion

- .1 Nothing herein contained can be constructed to relieve the Trade from making good and perfect work in all usual details of construction and in accordance with best standard practice and in strict compliance with provisions of all laws and ordinances, and the rules and regulations of any duly constituted public body having jurisdiction over this work.
- .2 This Trade shall be held responsible to provide and furnish all necessary labour and to bear all expenses incidental to the satisfactory completion of the work.

1.23 Manufacturer's Review

- .1 It shall be the responsibility of the Mechanical Contractor to have the equipment supplier or his representative review all proposed connections, clearances, sizes, valves, breakers, etc. including wire and pipe sizes to his equipment before installation commences. At that time, he shall inform the Departmental Representative of any changes required to make the equipment function satisfactorily.
- .2 Provide the Contractor with a letter accepting all connections as proposed and where required, recommend necessary changes.
- .3 If any changes or additional material and labour are required to make the equipment function properly to capacity and the manufacturer has not pointed out this work prior to commencement of work, the additional and/or corrective work shall then be done at the expense of the equipment supplier.

1.24 Warranties

- .1 Make good all defects other than normal wear and tear during the life of the warranty period specified in the General Conditions of the contract. Warrant all work and installed equipment to work quietly and satisfactorily and to accomplish the work for which it was installed during the life of the warranty. At any time during this period, make any necessary changes and adjustments, or replacements, to accomplish this at no additional cost to the Departmental Representative.
- .2 Submit warranties in maintenance manuals as specified in Section 01 78 00.

1.25 Related Work
Performed by Others

- .1 Excavating and Backfilling.
- .2 Concrete housekeeping pads.
- .3 Saw-cutting of concrete/masonry walls,
floors and/or ceilings.

1.26 APPENDIX A 17-343

SHOP DRAWING SUBMITTAL FORM

General Contractor
Phone Number:

Fax No.

Mechanical Contractor
Phone Number:

Fax No.

Mechanical Contractor Project Representative

Item

Number of Copies

Supplier

Manufacturer

Specification Section and Item

Drawing Reference

Specified Options Indicated ***Yes*** ***No***

***Items are in Conformance with Plans and Specifications Confirmed
by Contractor.*** ***Yes*** ***No***
(If No, explain)

Contractor's Signature

Date

PART 1 - GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Standard 90.1-latest edition.
- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C 449M, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .6 ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.
 - .2 CAN/CGSB-51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
 - .3 CAN/CGSB-51.10, Mineral Fibre Board Thermal Insulation.
 - .4 CAN/CGSB-51.11, Mineral Fibre Thermal Insulation Blanket.
 - .5 CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing.
 - .6 CAN/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
 - .7 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .8 CGSB 51-GP-53M, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .4 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials

and Assemblies.

- .5 National Building Code of Canada - 2015.
- .6 National Plumbing Code of Canada - 2015.
- .7 Model National Energy Code - 2015.
- .8 Manufacturer's Trade Associations:
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.

1.2 Definitions

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible, chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval, manufacturer's catalogue literature related to installation, fabrication for duct, fittings and jointing recommendations.

1.4 Manufacturer's Instructions

- .1 Manufacturer's installation instructions to be submitted to the Departmental Representative upon request.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

1.5 Delivery, Storage and Handling

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .2 Protect from weather, construction traffic and against damage from any source.
- .3 Store at temperatures and conditions required by manufacturer.

PART 2 - PRODUCTS

2.1 Fire and Smoke Rating

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25 unless noted otherwise below.
 - .2 Maximum smoke developed rating: 50.

2.2 Mineral Fibre Insulation

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 23.9°C mean temperature when tested in accordance with ASTM C 335.
- .3 TIAC Code A-1: Rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9.
 - .2 Maximum "k" factor: to CAN/CGSB-51.9.
- .4 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.9.
 - .2 Jacket: to CGSB 1-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.9.
- .5 TIAC Code C-1: Rigid mineral fibre board, unfaced.
 - .1 Mineral fibre: to CAN/CGSB-51.10.
 - .2 Maximum "k" factor: to CAN/CGSB-51.10.
- .6 TIAC Code C-4: Rigid mineral fibre board faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.10.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.10.

- .7 TIAC Code C-2: Mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/CGSB-51.11.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.11.
 - .4 Insulation: to CAN/CGSB-51.40 with vapour retarder jacket.
 - .5 Jacket: to CGSB 51-GP-52Ma.
 - .6 Maximum "k" factor: to CAN/CGSB-51.40.

2.3 Glass Fibre Board

- .1 To have a maximum operating temperature of 232°C and ULC flame spread rating of 15.

2.4 Jackets

- .1 Canvas (exposed):
 - .1 227 g. cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C 921.
 - .2 Lagging adhesive: Compatible with insulation.

2.5 Accessories

- .1 Stainless steel wire, 1.27mm, Type 304, dead soft annealed.
- .2 Galvanized wire, 1.79mm, annealed.
- .3 Stainless steel mesh, hexagonal mesh, 20 gauge, Type 304.
- .4 Galvanized mesh, hexagonal mesh, 15 gauge, galvanized annealed.
- .5 Aluminum straps, will be 13mm x 0.51mm.
- .6 Stainless steel straps, will be 13mm x 0.51mm, Type 304, dead soft.
- .7 Lagging adhesive: as required.
- .8 Vapour barrier mastic: as required.
- .9 Fasteners: 2 mm diameter pins with 35 mm diameter clips. Length of pins to suit thickness of insulation.

2.6 Vapour Retarder
Lap Adhesive

- .1 Water based, fire retardant type, compatible with insulation.

2.7 Indoor Vapour
Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 Equipment
Below Ambient

- .1 The insulation will be fibre glass duct insulation, rigid or flexible, manufactured from fine inorganic glass fibre bonded by a thermal setting resin.
- .2 The facing for the insulation will consist of high intensity white, chemically-treated kraft paper, fibre glass yarn reinforced and aluminum foil, laminated together with a nonflammable adhesive.

PART 3 - EXECUTION

3.1 Pre-Installation Requirements

- .1 Pressure testing of equipment and adjacent piping systems to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

3.2 Installation

- .1 Provide vapour retarder as recommended by manufacturer to suit application.
- .2 Install in accordance with TIAC National Standards:
 - .1 Hot equipment: to TIAC code 1503-H.
 - .2 Cold equipment: to TIAC code 1503-C.
- .3 Apply materials in accordance with insulation and equipment manufacturers instructions and this specification.

- .4 Use two layers with staggered joints when required nominal wall thickness exceeds 3".
- .5 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .6 Supports, Hangers:
 - .1 Apply high compressive strength insulation such as Ca-Si, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .7 On flat surfaces glass fibre insulation will be applied by impaling the insulation on No. 9 gauge pins, spot welded, on a maximum of 300mm centres and shall be placed no closer than 100mm from the edge of the board. Secure with 38mm O.D. speed washers.
- .8 On curved surfaces secure the insulation with galvanized steel wire or with aluminum straps.

3.3 Accessories

- .1 Where vapour barriers are used, wire, wire mesh and straps will be stainless steel.
- .2 Where no vapour barrier is required wire, and wire mesh will be galvanized steel. Straps may be galvanized steel or aluminum.

3.4 Workmanship

- .1 Install insulation in first class manner with smooth and even surfaces. Outline of insulation shall be true shape. Outline of fitting insulation shall be shaped to blend with adjacent covering. Do not use scrap pieces of insulation where full size sections will fit.

3.5 Equipment
Insulation Schedule

Equipment	Insulation	Thickness
Domestic Water Backflow Preventers	Removable Insulation Blanket	25 mm

END OF SECTION

PART 1 - GENERAL

1.1 References

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):
 - .1 ASHRAE Standard 90.1-latest edition.

- .2 American Society for Testing and Materials (ASTM):
 - .1 ASTM B 209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate.
 - .2 ASTM C 335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C 411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - .4 ASTM C 449M, Standard Specification for Mineral Fibre-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .5 ASTM C 795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
 - .6 ASTM C 921, Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

- .3 Canadian General Standards Board (CGSB):
 - .1 CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Piping, Machinery and Boilers.
 - .2 CAN/CGSB-51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
 - .3 CAN/CGSB-51.11, Mineral Fibre Thermal Insulation Blanket.
 - .4 CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing.
 - .5 CAN/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
 - .6 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal

- Insulation.
- .7 CGSB 51-GP-53M, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .4 Manufacturer's Trade Associations:
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .5 Underwriters' Laboratories of Canada (ULC):
 - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .6 National Building Code of Canada - 2015.
- .7 National Plumbing Code of Canada - 2015.
- .8 Model National Energy Code - 2015.

1.2 Definitions

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible, chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.
- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 Shop Drawings

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.
- .3 Submit shop drawings for: Pipe Insulation, Covering.

1.4 Manufacturer's
Instructions

- .1 Submit manufacturer's installation instructions for incorporation into the operation and Maintenance Manuals.

1.5 Delivery,
Storage and Handling

- .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Protect from weather, construction traffic.
- .3 Protect against damage from any source.
- .4 Store at temperatures and conditions required by manufacturer.

PART 2 - PRODUCTS

2.1 Fire and
Smoke Rating

- .1 In accordance with CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 Fibreglass Insulation

- .1 Pipe insulation will be pre-formed glass fibre having a nominal density of 88.2 kg/m³.

2.3 Mineral
Fibre Insulation

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.

2.4 Insulation Securement

- .1 Tape: Self-adhesive, aluminum, reinforced, 50mm wide minimum.
- .2 Contact adhesive: Quick setting.

- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19mm wide, 0.50 mm thick.

2.5 Vapour Retarder Lap Adhesive

- .1 Water based, fire retardant type, compatible with insulation.

2.6 Indoor Vapour Retarder Finish

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 Jackets

- .1 Polyvinyl Chloride (PVC) - for use on exposed piping in utility type rooms:
 - .1 One-piece moulded type to CGSB 51-GP-53M with pre-formed shapes as required.
 - .2 Colours: White.
 - .3 Minimum service temperatures: -20°C.
 - .4 Maximum service temperature: 65°C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Thickness: 0.50 mm.
 - .7 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
- .2 Canvas:
 - .1 8 oz. cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C 921.
 - .2 Lagging adhesive: Compatible with insulation.
- .3 Aluminum (exterior piping):
 - .1 To ASTM B 209.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Stucco embossed,

- corrugated.
- .4 Joining: Longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.50 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19mm wide, 0.50 mm thick at 305 mm spacing.

2.8 TIAC Codes

- .1 TIAC Code A-3: Rigid moulded mineral fibre with factory applied vapour retarder jacket. Vapour retarder jacket is not required for hot systems (i.e. steam, condensate, hot water heating, glycol/water heating).
 - .1 Mineral fibre: to CAN/CGSB-51.9.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.9.
- .2 TIAC Code C-2: Mineral fibre blanket faced with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/CGSB-51.11.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB

PART 3 - EXECUTION

3.1 Pre-Installation Requirement

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified by the Departmental=s representative.
- .2 Surfaces to be clean, dry, free from foreign material.

3.2 Installation

- .1 Install in accordance with TIAC National Standards.

- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 50mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.3 Removable, Pre-Fabricated, Insulation, And Enclosures

- .1 Application: At expansion joints, balancing valves, flanges and unions at equipment, pump bodies.
- .2 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .3 Insulation:
 - .1 Insulation, fastenings and finishes: same as system.
 - .2 Jacket: Canvas.

3.4 Piping Insulation Schedules

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-3.
 - .1 Securements: Tape at 305mm oc.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.

- .3 Installation: TIAC Code: 1501-C.
- .3 TIAC Code: C-2 with vapour retarder jacket.
 - .1 Insulation securements: 75mm wide pressure sensitive.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.
- .4 Thickness of insulation to be as listed in following table.
 - .1 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temperature °C	Type	Pipe Sizes and Insulation Thickness (mm)				
			to 25	32-50	63-100	125-150	200 & Over
Domestic Hot Water Recirculation	3 - 60	A-3	25	25	N/A	N/A	N/A
Domestic HWS	38 - 60	A-3	25	25	38	38	38
Domestic CWS with Vapour Retarder	4 - 15	A-3	25	25	25	25	25

- .5 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Exposed in mechanical rooms: PVC jacket where the temperature is less than 65°C.
 - .3 Concealed, indoors: canvas on valves, fittings. No further finish.
 - .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .5 Finish attachments: SS bands, at 150mm oc.
 - .6 Installation: To appropriate TIAC code CRF/1 through CPF/5.

END OF SECTION

