

1 General

1.1 GENERAL

- .1 This section covers items common to all sections of Divisions 20 through 25.

1.2 EXAMINATION OF SITE AND DRAWINGS

- .1 The Contractor shall examine the site and local conditions affecting the work under this Contract. No additional costs will be considered due to existing conditions.
- .2 The drawings do not show all structural or mechanical details and where accurate dimensions are required these dimensions shall be taken by the Contractor in the field. The Contractor shall confirm to their own satisfaction the accuracy of these field measurements and all necessary minor changes to piping/ducting/equipment to accommodate field conditions shall be approved by the departmental representative and made at no charge to the Owner.
- .3 The departmental representative reserves the right to alter locations of pipes, ducts or equipment without incurring additional costs provided such alterations are made before the Contractor has begun fabrication of the work in question.
 - .1 The Contractor shall carefully examine the structural, civil, architectural, and electrical drawings and confirm to their own satisfaction that the work under this division can be carried out without changes to the equipment as shown on these drawings. Before commencing the work, the Contractor shall examine the work of other trades and report at once any defect or interference affecting the work of this division.
 - .2 Notes on the drawings are intended to form a part of this specification and must be examined by the Contractor.

1.3 SCOPE OF WORK

- .1 This work includes, but is not limited to, the supply and installation of all supervision, labour, permits, equipment, materials, and consumables necessary to provide this facility with complete and operational systems listed below, as indicated on the drawings, and described in the specifications:
 - .1 The work provided in these tender documents shall be coordinated by the General Contractor for phasing of work.
 - .2 Fire protection consists of installing wet and dry pipe sprinkler systems throughout the building.
 - .3 Plumbing consists of the supply and installation of storm drainage from the roof drains to 1.5 meters from the foundation wall and washrooms and specialty fixtures including the water supply, waste and vent piping required for these fixtures.
 - .4 The installation of refrigeration and condensate drain piping for air conditioners and variable refrigerant flow terminal units.
 - .5 Heating, ventilation and air conditioning consists of the supply and installation of heat recovery units, variable refrigerant terminal units, condensing units, ductwork and reheat coils as specified and as indicated on the drawings.
 - .6 The controls will be a direct digital controls (DDC) system.

1.4 PRODUCT SPECIFICATIONS AND STANDARDS

- .1 All equipment and materials specified to conform to an applicable code and/or standard, and shall be listed and/or labelled under the provisions of such code or standard, when available.
- .2 Product description shall take precedence over product model numbers as manufacturers may change numbers during design and tender bid periods.
- .3 Reference is made in the documents to NPS which is to be understood as Nominal Pipe Size in inches, inside or outside diameter as applicable to the piping or tubing product in question.

1.5 EQUIPMENT INSTALLATION

- .1 Unions or flanges: provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: pipe to floor drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.

1.6 ANCHOR BOLTS AND TEMPLATES

- .1 Supply anchor bolts and templates required for the work of this division for installation by other divisions.

1.7 TRIAL USAGE

- .1 The departmental representative may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

1.8 PROTECTION OF OPENINGS

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

1.9 ELECTRICAL

- .1 Electrical work to conform to Division 26. Supply and installation responsibility is indicated in the mechanical and electrical specifications and on the mechanical and electrical drawings as appropriate.
- .2 Control wiring and conduit, 120V and under, shall be supplied and installed by this trade. Refer to Division 26 for quality of materials and workmanship.

1.10 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by the departmental representative for temporary use. Final acceptance of equipment will not occur until specified motor is installed.

- .3 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C, 3 phase, 208 V, unless otherwise specified or indicated.

1.11 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 Standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .5 Motor slide rail adjustment plates to allow for centre line adjustment.

1.12 GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

1.13 EQUIPMENT SUPPORTS

- .1 For equipment supports not supplied by equipment manufacturer: provide information required for fabrication by Section 05 50 00 - Metal Fabrications.
- .2 Equipment supports supplied by equipment manufacturer: specified elsewhere in Divisions 21, 22 and 23.

1.14 SLEEVES

- .1 Pipe sleeves: provide at points where pipes pass through masonry, concrete or fire rated assemblies and as indicated.
- .2 Schedule 40 steel pipe.
- .3 Sleeves with annular fin continuously welded at midpoint:
 - .1 Through foundation walls.
 - .2 Where sleeve extends above finished floor.
- .4 Sizes: minimum 6 mm clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade and 25 mm above other floors.
- .6 Fill voids around pipes:
 - .1 Caulk between sleeve and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
 - .2 Where sleeves pass through walls or floors, provide space for firestopping.
 - .3 Where pipes/ducts pass through fire rated walls, floors and partitions, maintain fire rating integrity.
 - .4 Ensure no contact between copper tube or pipe and ferrous sleeve.
 - .5 Fill future-use sleeves with lime plaster or other easily removable filler.
 - .6 Coat exposed exterior surfaces of ferrous sleeves with heavy application of zinc rich paint to CGSB 1-GP-181M+Amdt-Mar-78.

1.15 PREPARATION FOR FIRESTOPPING

- .1 Uninsulated unheated pipes not subject to movement: no special preparation.
- .2 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe to move without damaging firestopping material.
- .3 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier of fire separation.

1.16 ESCUTCHEONS

- .1 On pipes passing through walls, partitions, floors and ceilings in finished areas.
- .2 Chrome plated plastic split ring, pressfit.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.
- .5 Standard of Acceptance: Belanger.

1.17 TESTS

- .1 Give 24 h written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by the departmental representative.
- .3 Conduct tests in presence of the departmental representative when requested.

- .4 Bear costs including retesting and making good.
- .5 Piping:
 - .1 General: maintain test pressure without loss for 4 h unless otherwise specified.
 - .2 Test drainage, waste and vent piping to National Plumbing Code and departmental representative. Perform ball test on all underground drainage piping systems.
 - .3 Test domestic hot, cold and recirculation water piping at 1-1/2 times system operating pressure or minimum 860 kPa whichever is greater.
 - .4 Test refrigerant piping to Section 23 81 23 for a 2 hour duration.
 - .5 Test fire systems in accordance with the departmental representative and as specified elsewhere.
- .6 Equipment: test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.

1.18 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work. Outdoor ferrous supports to be painted with two coats of enamel paint in addition to the primer coat.
- .2 Quality and color selection relevant to Section 09 91 23 - Painting.
- .3 Prime and touch up marred manufacturers' finished paintwork to match original.
- .4 Restore to new condition, manufacturers' finishes that have been extensively damaged.

1.19 SPARE PARTS

- .1 Furnish spare parts in accordance with Section 01 10 01 – General Requirements.
 - .1 One set of belts for each piece of machinery.
 - .2 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set, for each applicable piece of equipment.
 - .3 One set of mechanical seals for each pump.
 - .4 One casing joint gasket for each pump.
 - .5 As indicated.

1.20 ACCESS DOORS

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm for body entry and 300 x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Special areas such as tiled surfaces: use stainless steel with brushed satin or polished finish as directed by the departmental representative.
 - .2 Remaining areas: use prime coated steel.
- .4 Installation:
 - .1 Locate so that concealed items are accessible.
 - .2 Locate so that hand or body entry (as applicable) is achieved.

.3 Installation is specified in applicable sections.

.5 Standard of Acceptance: Zurn, Ancon-Lehage, Jay R. Smith.

1.21 DIELECTRIC COUPLINGS

.1 General:

.1 To be compatible with and to suit pressure rating of piping system.

.2 Where pipes of dissimilar metals are joined.

.2 Pipes NPS 2 and under: isolating unions.

.3 Pipes NPS 2-1/2 and over: isolating flanges.

1.22 DRAIN VALVES

.1 Locate at low points and at section isolating valves unless otherwise specified.

.2 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

1.23 THERMOWELLS

.1 Thermowells for controls instrumentation shall be supplied by Controls Contractor for installation by Mechanical Contractor in locations as directed by Controls Contractor.

1.24 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 Division 22 and 23, manufacturers to provide demonstrations and instructions.

.3 Use operation and maintenance manual, record drawings, audio visual aids, etc. as part of instruction materials.

.4 Instruction duration time requirements as specified in appropriate sections, and minimum as follows:

.1 Plumbing Systems: 1/2 day (site time).

.2 Heating, ventilation, and air conditioning systems: 1 day (site time).

.3 Controls: see Section 25 00 00.

.5 Where deemed necessary, the departmental representative may record these demonstrations on video tape for future reference.

1.25 OPERATION AND MAINTENANCE MANUAL

.1 Provide operation and maintenance data for incorporation into manual specified in Section 01 10 01 – General Requirements.

.2 Operation and maintenance manual to be reviewed by, and final copies deposited with, the 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.
- .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 20 05 93 - Testing, Adjusting and Balancing.
- .6 Reviews.
 - .1 Submit 3 copies of draft Operation and Maintenance Manual and one electronic copy to the Departmental Representative for review.
 - .2 Submission of individual data will not be accepted unless so directed by the Departmental Representative.
 - .3 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.

1.26 SHOP DRAWINGS

- .1 Submit shop drawings and product data in accordance with Section 01 10 01 – General Requirements.
- .2 Shop drawings and product data shall show:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances, eg. access door swing spaces.
- .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.
 - .6 Electrical requirements.
 - .7 Accessories.

1.27 CLEANING

- .1 Clean mechanical (building) systems in accordance with Section 01 10 01 – General Requirements.
- .2 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and ventilating units.
- .3 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.

1.28 RECORD DRAWINGS

- .1 Site records:
 - .1 The departmental representative will provide 1 set of white prints of mechanical drawings. Mark thereon all changes as work progresses and as changes occur. This shall include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 On a weekly basis, transfer information to prints, to show all work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection at all times.
- .2 Record drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
 - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "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 record drawings.
 - .5 Submit completed reproducible record drawings with Operating and Maintenance Manuals.
- .3 Submit copies of record drawings for inclusion in final TAB report.

1.29 SUSTAINABLE DESIGN SUBMITTALS

- .1 Construction waste management plan.
 - .1 A Construction Waste Management Plan is in place to divert waste material from landfill. Wherever practical, send waste material for reuse or recycling, and generally document this for the contractor's waste management final report.
- .2 Recycled Content.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Requiring Recycled Content".
 - .2 If products within this section are indicated on the "List of Products Requiring Recycled Content", only products with recycled content will be acceptable.
 - .3 For products not identified on list, source products with highest recycled content available when practical.

- .4 Include following information with product data submission.
 - .1 Percentage of pre-consumer and post-consumer recycled content for each product.
- .3 Regional Materials.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for “List of Products Required to be Locally Sourced”.
 - .2 If products within this section are indicated on the “List of Products Required to be Locally Sourced”, include following information with Product Data submission:
 - .1 Extraction/Manufacturing location(s): Indicate location of extraction site or manufacturing plant, and indicate distance between extraction site or manufacturing plant and Project site.
- .4 Adhesives and Sealants.
 - .1 Include following information with Product Data submission for materials specified under this section:
 - .1 Submit manufacturer’s certification indicating VOC limits of Products used onsite and within the building envelope. Product shall comply with California’s SCAQMD #1168.
- .5 Paints and Coatings.
 - .1 Provide low VOC Products as specified herein and complying with local regulations regarding toxic and hazardous materials.
 - .2 Ensure primers, paints and coatings used onsite and within building envelope meet or exceed requirements of following standards:
 - .1 Interior and Exterior Paints: GS-11
 - .2 Anti-Corrosive Paint: GS-11
 - .3 Clear Wood Finishes and other coating not covered in GS-11: SCAQMD #1113.
 - .3 Submit manufacturer’s certification indicating VOC limits of Products.
- .6 If requesting substitute product, ensure proposed substitution achieves above stated goals.

1.30 MAX. VOC CONTENT FOR SOLVENT CLEANING ACTIVITIES

- .1 Following are some of the Maximum allowed VOC Content for following activities, as per SCAQMD Rule 1171-9 (refer to SCAQMD manual for complete list and updates):
 - .1 Product cleaning during onsite surface preparation for coatings or adhesives application, and repair and maintenance cleaning:
 - .1 General maximum VOC 25g/L.
 - .2 Electrical apparatus components and electronic components.
 - .3 Cleaning of coatings or adhesives application equipment max. VOC 25g/L.
 - .2 Refer to SCAQMD for additional information and clarification and complete list of applications.
 - .3 Any discrepancies are to be approved by Departmental Representative. Obtain written approval prior to use on site.

1.31 COMMISSIONING

- .1 Commissioning shall be performed in accordance with Section 01 91 13 – General Commissioning Requirements.

- .2 Installing trades shall provide site attendance by qualified technicians to assist with the commissioning process, verify in writing that tests and adjustments have been made for each item requiring commissioning, and submit verification to the departmental representative for review. Commissioning and verification requirements are indicated in detail in the specifications that follow for some equipment/systems, however, as a minimum, verification shall be a list of each piece of equipment showing the tag # for the equipment, room numbers, date commissioned, personnel's name performing the work and comments indicating the work performed. Report may be hand printed in ink and must be legible. Submit proposed method of commissioning to the departmental representative prior to performing the work, showing all equipment to be commissioned.

END OF SECTION

1 General

1.1 RELATED SECTIONS

- .1 Section 07 84 00 – Firestopping; supply and installation of firestopping.

1.2 WORK INCLUDED

- .1 Provide all labour, materials, products, equipment and services to supply and install the basic mechanical materials indicated on the Drawings and specified in Division 20 through 25 of these Specifications.

1.3 IDENTIFICATION OF MECHANICAL SERVICES

- .1 Identify all mechanical services after finish painting is complete.
- .2 Use consistent terminology:
 - .1 With the Drawings and Specifications
 - .2 With the departmental representative's requirements and standards.
- .3 Mark valve and equipment identification on Record Drawings.
- .4 Provide typewritten master lists for each Equipment Room. Frame under glass. Insert copies in Operating and Maintenance Instruction Manuals.

1.4 PIPE IDENTIFICATION

- .1 Provide SMS Wrap-Mark on all pipe coverings, using Wrap-Mark pipe markers with alternating flow arrow wording. For outside diameters up to 150 mm, allow marker to completely wrap pipe. For larger outside diameters, secure markers with stainless steel springs. Secure markers on vertical piping and elsewhere where markers could be inadvertently moved.
- .2 Locate identification and flow arrows so they can be seen clearly from floor and service platforms.
 - .1 At least once in each room
 - .2 At each piece of equipment
 - .3 At each branch close to connection point to main piping and ductwork
 - .4 At not greater than intervals of 15 metres on straight runs of exposed piping and ductwork
 - .5 At entry and leaving point to pipe and duct chases, or other concealed spaces
 - .6 Both sides where piping and ductwork passes through walls, partitions and floors
 - .7 On vertical pipes and ducts approximately 1800 mm above floor
 - .8 Behind each access door and panel
 - .9 At valves, identify piping upstream of valves and identify branch, equipment, building part or building serviced downstream of valve.
- .3 Colour code pipes to meet code and the departmental representative's requirements. At minimum, colour code pipes with 50 mm wide bands in accordance with the detail shown on the drawings.
- .4 Identify electrical tracing of pipes on pipe insulation.

1.5 VALVE TAGS

- .1 Provide 40 mm dia., 1 mm thick brass tags with 10 mm high die-stamped black letters.
- .2 Attach to valve handles with 100 mm long brass chains through a hole in the handle.
- .3 Tag all valves except for small valves isolating a single piece of equipment such as a unit heater, fan coil unit, terminal reheat coil and radiation section.

1.6 EQUIPMENT NAMEPLATES

- .1 Identify equipment, starters, and, remote control devices in a manner consistent with the Drawings.
- .2 Use solid black capitalized lettering 100 mm high.
- .3 Where equipment size does not permit stencil identification, use lamacoid labels, engraved white on black, mechanically fastened to the equipment. Minimum lettering size 10 mm.

1.7 FLOW DIAGRAMS

- .1 Prepare neat diagrams 1200 mm x 900 mm of piping systems to identify equipment and valves.
- .2 Insert legible page size copies into each Operating and Maintenance Manual.
- .3 Install diagrams, framed under glass, on Equipment Room walls where directed by the Departmental Representative/Contractor.

1.8 SUSTAINABLE DESIGN SUBMITTALS

- .1 Construction waste management plan.
 - .1 A Construction Waste Management Plan is in place to divert waste material from landfill. Wherever practical, send waste material for reuse or recycling, and generally document this for the contractor's waste management final report.
- .2 Recycled Content.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Requiring Recycled Content".
 - .2 If products within this section are indicated on the "List of Products Requiring Recycled Content", only products with recycled content will be acceptable.
 - .3 For products not identified on list, source products with highest recycled content available when practical.
 - .4 Include following information with product data submission.
 - .1 Percentage of pre-consumer and post-consumer recycled content for each product.
- .3 Regional Materials.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Required to be Locally Sourced".
 - .2 If products within this section are indicated on the "List of Products Required to be Locally Sourced", include following information with Product Data submission:
 - .1 Extraction/Manufacturing location(s): Indicate location of extraction site or manufacturing plant, and indicate distance between extraction site or manufacturing plant and Project site.

- .4 Adhesives and Sealants.
 - .1 Include following information with Product Data submission for materials specified under this section:
 - .1 Submit manufacturer's certification indicating VOC limits of Products used onsite and within the building envelope. Product shall comply with California's SCAQMD #1168.
 - .5 Paints and Coatings.
 - .1 Provide low VOC Products as specified herein and complying with local regulations regarding toxic and hazardous materials.
 - .2 Ensure primers, paints and coatings used onsite and within building envelope meet or exceed requirements of following standards:
 - .1 Interior and Exterior Paints: GS-11
 - .2 Anti-Corrosive Paint: GS-11
 - .3 Clear Wood Finishes and other coating not covered in GS-11: SCAQMD #1113.
 - .3 Submit manufacturer's certification indicating VOC limits of Products.
 - .6 If requesting substitute product, ensure proposed substitution achieves above stated goals.
- 1.9 MAX. VOC CONTENT FOR SOLVENT CLEANING ACTIVITIES
- .1 Following are some of the Maximum allowed VOC Content for following activities, as per SCAQMD Rule 1171-9 (refer to SCAQMD manual for complete list and updates):
 - .1 Product cleaning during onsite surface preparation for coatings or adhesives application, and repair and maintenance cleaning:
 - .1 General maximum VOC 25g/L.
 - .2 Electrical apparatus components and electronic components.
 - .3 Cleaning of coatings or adhesives application equipment max. VOC 25g/L.
 - .2 Refer to SCAQMD for additional information and clarification and complete list of applications.
 - .3 Any discrepancies are to be approved by Departmental Representative. Obtain written approval prior to use on site.
- 1.10 COMMISSIONING
- .1 Perform commissioning activities in accordance with Section 20 04 00 - Mechanical General Requirements.
- 2 ProductsINSERTS
- .1 Submit proposed materials and methods for cast-in-place inserts.
 - .2 Where inserts must be placed after concrete is poured, use Phillips Red Head Multiset II Anchor system or equivalent Hilti System.

2.2 PIPE HANGERS

- .1 Provide pipe hangers and supports for all piping. Provide hangers in accordance with the following requirements. Provide steel supports in accordance with the subsequent article in this specification section. Provide galvanized steel hangers and supports with galvanized fittings and accessories where exposed to direct contact with water or to possible high humidity conditions where condensation can occur.
- .2 Provide manufactured hangers, accessories and supports in accordance with ANSI B31.1 and MSS SP58, SP69, SP89 and SP90 similar to the Grinnell or Myatt figures numbers below.
- .3 Select products to ensure adequate safety factors under anticipated loads.
- .4 Provide upper attachments as follows:
 - .1 Standard beam clamp for normal service - Grinnell Fig 133 with Fig 290 or Fig 278 or Myatt Fig 500 with Fig 480 or Fig 440.
 - .2 Standard side beam clamp for normal service - Grinnell Fig 225 or Myatt Fig 505.
 - .3 Top beam clamp - Grinnell Fig 92 or Myatt Fig 406.
 - .4 C clamp - Grinnell Fig 86 or Myatt Fig 586.
 - .5 Angle clip for light duty side mounting - Grinnell Fig 202 or Myatt Fig 542.
- .5 For vertical adjustment of hanger rods, provide forged steel turnbuckle - Grinnell Fig 230 or Myatt Fig 475.
- .6 Provide pipe attachments as follows:
 - .1 Adjustable swivel rings for uninsulated fire service piping - ULC approved - Grinnell Fig 69 or Myatt Fig 41.
 - .2 Clevis hanger for copper piping up to and including 100 mm diameter - Grinnell Fig CT-65 plastic coated or Myatt Fig 56 epoxy coated.
 - .3 Swivel ring hanger for copper tubing up to and including 25 mm diameter - Myatt Fig 43 epoxy coated.
 - .4 Standard duty clevis hanger for steel piping - Grinnell Fig 260 or Myatt Fig 124.
 - .5 Standard duty long clevis hanger for steel piping - Grinnell Fig 300 or Myatt Fig 124L.
- .7 Provide vertical pipe supports as follows:
 - .1 Riser clamp for copper pipe - Grinnell Fig CT121C plastic coated or Myatt Fig 186 epoxy coated.
 - .2 Riser clamp for steel or cast iron pipe - Grinnell Fig 261 or Myatt Fig 182 or Fig 183.
- .8 Provide supports for other piping types such as plastic, mechanically fused or packed joint pipe according to the pipe manufacturer's published recommendations. Support piping continuously where required to prevent sagging.
- .9 Provide protection saddles where insulated piping is supported from below.
 - .1 For high temperature insulated pipe - Grinnell Fig 160 or Fig 165 or Myatt Fig 210 or Fig 240.
 - .2 For insulated pipe with vapour barrier for low temperature service, insulate pipe with calcium silicate at hangers and provide Grinnell Fig 167 or Myatt Fig 251.

- .10 Provide roll type supports where shown on the drawings and where longitudinal movement may occur. Provide single pipe rolls - Grinnell Fig 177 or Myatt Fig 262 where supported from below and Grinnell Fig 171 or Myatt Fig 261 where suspended. Provide spring cushions where slight vertical movement is likely and cushioning required - Grinnell Fig 178 or Myatt Fig 880.
- .11 Provide Grinnell or Myatt engineered constant support hangers on piping subject to vertical movement exceeding 40 mm due to vertical pipe expansion.

2.3 EQUIPMENT RIGGING SUPPORTS

- .1 Provide eyebolts suitable for block and tackle connection, adequately supported by the structure above for:
 - .1 Heat recovery equipment wheel and fans
 - .2 Motors
 - .3 Other equipment which will require block and tackle handling

2.4 SLEEVES, WALL AND FLOOR PLATES

- .1 For pipe sleeves, use machine cut and reamed standard weight steel piping.
- .2 Concealed perimeter risers and runouts may have sleeves of 1.31 mm galvanized steel set around section of insulation to provide freedom of movement of piping. Extend 50 mm above finished floor level.
- .3 For piping through exterior walls, cooperate with the waterproofing trade at all times, and do not break any waterproofing seal without consent of the waterproofing trade. Provide waterproof link seals as detailed on Drawings.
- .4 Provide leak plates where pipe sleeves pass through exterior building walls. Each leak plate shall be a 3.42 mm steel plate, welded to the sleeve, 100 mm diameter greater than sleeve outside diameter.
- .5 Provide 1.31 mm galvanized steel duct sleeves. Provide adequate bracing for support of sleeves during concrete and masonry work. For fire rated floors and walls, build fire damper assemblies into structure to attain fire rated construction, in a manner acceptable to the Departmental Representative.
- .6 Cover pipe sleeves in walls and ceilings of finished areas, other than Equipment Rooms, with satin finish stainless steel, or satin finish chrome or nickel plated brass escutcheons, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks, however, may be used.
- .7 Cover exposed duct sleeves in finished areas with 1.31 mm galvanized steel plates in the form of duct collars. Fix in position with non-ferrous metal screws.

2.5 PROVISION FOR PIPE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- .1 Where space limitations do not permit the use of expansion loops or offsets, provide Flexonics Expansion Joints properly selected for system operating pressures according to the following:
 - .1 For piping up to and including 65 mm, select ends to suit specified pipe fittings. Pressure shall be external to the bellows. Pressure ratings for Model H and HB expansion compensated as 1400 kPa and 1050 kPa

- .2 Copper Piping - Flexonics Model HB expansion compensator with two-ply bellow, all bronze construction.
- .3 For piping 75 mm and above, use flanged ends.
- .4 Copper Piping - Flexonics controlled, flexing expansion joint with monel pressure carrier, and brass flanged ends.
- .5 Submit for Departmental Representative review prior to installation, drawings showing the location of expansion joints, anchors and guides. Show details of proposed connection to structure and loads to be imposed. All Drawings must be signed by a Professional Engineer registered in the Province of New Brunswick.

2.6 STRAINERS

- .1 Provide pipeline strainers with stainless steel screens according to the following:

Pipe Schedule	Pipe Size	Type	Spirax Canada Limited Model #	Screen Perforation
Copper	All sizes	Y	BT Bronze	0.76mm 20 Mesh
Steel	Up to 50mm	Y	IT Cast Iron	0.76mm 20 Mesh
Steel	65mm to 150mm	Y	IF Standard for water	3mm
Steel	200mm and up		Basket 528B Cast Iron	3mm

- .2 Acceptable Alternates: Armstrong, ITT Bell & Gossett.
- .3 Supply strainers with extra construction screens and remove after systems have been thoroughly cleaned.
- .4 Equip each strainer 40 mm and smaller in size, with plugged blow off tappings.
- .5 Equip each strainer 50 mm and larger in size, with blow off tapping. Provide blow off piping complete with capped shut off valve. Terminate in downward vertical position. Size blow off piping and valve the same size as the blow off tapping.
- .6 Ensure that each strainer can be isolated from piping systems with isolating valves on each side of strainer, and which are not more than 3 metres away from strainer.
- .7 Provide strainers in the following locations:
 - .1 At the suction side of each pump
 - .2 Immediately upstream of each pressure reducing valve
 - .3 Where shown on Detail Drawings
- .8 Provide Victaulic No. 730 tee type or No. 732 wye type strainers where Victaulic piping systems are used.

2.7 DRAINS

- .1 Provide 40 mm minimum size copper pipe drains from overflows, condensate pans and pump bases to floor drains.
- .2 Provide minimum 20 mm ball valve with hose end adapter, metal cap and chain at all low points of all systems. Locate to allow easy connection of hose.
- .3 Provide 40 mm minimum size drains from ductwork connected to intake hoods and wall louvres. Equip drains with deep seal traps. Locate traps in heated areas.
- .4 Provide 20 mm valves with metal caps and chains at the base of all pipe risers. Install hose end ball valve in conjunction with 450 mm minimum length full line size dirt leg.

2.8 THERMOMETERS

- .1 Liquid thermometers shall be Trerice BX9 Series adjustable angle separable well type, calibrated in °C.
- .2 Thermometers shall be complete with fully adjustable angle hinge assembly, 225mm aluminum case, unbreakable window, lens front, red appearing mercury tubing and brass stem. Locate to be easily read from 1500 mm level.
- .3 Select thermometers to suit full temperature range of liquid. Operating temperature shall indicate at approximately mid point of scale.
- .4 Thermometers shall have a reservoir top to allow not less than 25% temperature over scale without damage.
- .5 Submit schedule in the form of Shop Drawings to show for each thermometer, the duty, location and scale range.
- .6 Provide thermometers in the following locations:
 - .1 Where shown on Detail Drawings and, in addition;
 - .1 On downstream side of mixing valves
 - .2 Domestic hot water storage tanks
 - .3 Where shown on the Mechanical Drawings
- .7 Supply to the departmental representative, for his use, two additional thermometers, representative of the above scale ranges.

2.9 PRESSURE GAUGE CONNECTIONS

- .1 Provide pressure gauge connections in the following locations:
 - .1 Where shown on Detail Drawings and, in addition;
 - .1 On entering domestic cold water services
 - .2 On suction and discharge sides of pumps and circulators
 - .3 On entering and leaving sides of strainers
 - .4 On entering and leaving sides of pressure reducing valves
 - .5 Where shown on Mechanical Drawings.
- .2 Provide Trerice No. 735 6 mm brass needle valves at each pressure gauge connection.
- .3 Where gauges are not connected, cap gauge connections after balancing of system.
- .4 Locate gauge connections to ensure that gauges can be read easily from a level 1500 mm above the floor.

2.10 PRESSURE GAUGES

- .1 Gauges shall be Terice 113 mm size No. 600B with black finish cast aluminum case, phosphor bronze Bourdon tube, brass rotary type movement, bronze bushed, silver brazed tip and socket joints, adjustable type pointer and calibrated in kPa and psi.
- .2 Install each gauge with Terice brass impulse dampener.
- .3 Select gauges to suit an overpressure of 25% without damage to movement. Normal operating pressure shall indicate approximately at midpoint of dial. Provide compound type gauge and scale for suction connection to pumps connected to open systems or equipment.
- .4 Provide gauges with an accuracy of 1% of full scale.
- .5 Submit a schedule to show for each gauge, the duty, location and dial range.
- .6 Provide gauges in the following locations:
 - .1 Where shown on Detail Drawings and, in addition;
 - .1 On entering domestic cold water services
 - .2 On suction and discharge sides of pumps and circulators
 - .3 On entering and leaving sides of pressure reducing valves
 - .4 Where shown on Mechanical Drawings.
- .7 Supply two additional gauges to the departmental representative for his/her use, representative of the above scale ranges.

2.11 ACCESS DOORS AND PANELS

- .1 Provide access to concealed mechanical equipment and components, which require inspection, adjustment, repair and preventive maintenance. Install systems and components to result in a minimum number of access doors and panels. Install equipment and components in locations readily accessible through doors and panels.
- .2 Supply for installation by others, doors, panels and frames. Ensure that access doors and panels are properly located.
- .3 Select access doors and panels to suit Architectural finishes and large enough to provide adequate access to equipment and components. Where personnel must pass through, provide 600 mm x 450 mm minimum size doors and panels. Otherwise, provide 300 mm x 300 mm minimum size doors and panels.
- .4 Provide access doors and panels with a fire rating required by the code governing the fire rating of the structure.
- .5 In tile walls, and washroom walls, supply minimum 2.78 mm, Type 304 stainless steel with #4 finish, with recessed frame secured with stainless steel countersunk flush head screws.
- .6 For all other surfaces, supply minimum 2.66 mm welded steel, flush type with concealed hinges, lock and anchor strap, and factory prime coat finish.

2.12 CONCRETE

- .1 Provide 100 mm concrete housekeeping pads under all floor mounted mechanical equipment and supports. Extend pads over the full equipment base and isolator area.

- .2 Concrete work, including housekeeping pads, required for mechanical work and shown on the Structural or Architectural Drawings will be provided by Division 3.
- .3 Provide other concrete work required for mechanical work, including reinforcing steel.
- .4 Housekeeping pads are to be painted by Division 9. Edges are to be painted a contrasting colour. Refer to finish schedule.

2.13 COVERS

- .1 Supply frames for installation by others.
- .2 Provide covers for pits and sumps.

2.14 STEEL

- .1 Provide steel required for mechanical work including supports, framing of openings and lintels over openings that are not shown on Structural or Architectural Drawings.
- .2 Provide steel of adequate strength to support equipment and materials during all operating and test conditions.

3 Execution

3.1 EXCAVATION AND BACKFILL

- .1 Conform to the requirements of Division 31.
- .2 Read subsurface information data.
- .3 Excavation and backfill required for mechanical work inside the building and to a point 1.5 m outside building shall be carried out by the Division listed in the following schedule:
 - .1 Excavation:
 - .1 Initial excavation to 150 mm (Division 31) above pipe inverts.
 - .2 Final excavation to pipe inverts (Division 20).
 - .2 Backfill
 - .1 Initial backfill with sand to (Division 20) 300 mm above top of pipes.
 - .2 Final backfill (Division 31).
- .4 Ensure that excavation work is executed to attain required inverts and grades.
- .5 Remove material excavated by mechanical and not to be reused, from the site.
- .6 Carefully prepare the bottom of pipe trench. Use one of the following bedding methods:
 - .1 In firm undisturbed soil, lay pipe directly on the soil and shape soil to fit the lower 1/3 segment of pipe and fittings.
 - .2 In rock, shale and where noted, excavate to 150 mm below and minimum 200 mm on each side of pipe. Form a 150 mm thick bedding using 10 mm crushed stone. Provide continuous support over at least the lower 1/3 segment of pipe.

- .3 In unstable soil, in fill and where soil has been disturbed during previous excavation work, excavate to at least 150 mm below bottom of pipe and form a reinforced concrete cradle supporting full length between firm support, or install piers down to undisturbed solid soil. Piers shall be at a maximum spacing of 2400 mm. Provide at least one pier for each pipe length. Support over at least the lower 1/3 segment of pipe.
- .7 Where excavation is necessary close to and below the level of any footing, backfill with 14,000 kPa concrete to the level of the highest adjacent footing. Do not proceed with the work prior to receiving written approval from Departmental Representative.
- .8 Obtain approval from Departmental Representative before backfilling.
- .9 Provide backfilling materials as specified in Division 31. Lay and compact as specified in Division 31.

3.2 PIPE AND EQUIPMENT INSTALLATION

- .1 Locate distribution systems, equipment and materials for maximum usable space, optimum service clearances and to accommodate current requirements and identified future expansion.
- .2 Coordinate mechanical services installation above typical floor modular ceilings to allow installation and future relocation of lights and air troffers without interfering with or requiring relocation of mechanical, electrical or other services, or removal of ceiling grid.
- .3 Include all pipe offsets required to eliminate interference with the work of other trades.
- .4 Install equipment and materials to present a neat appearance. Run piping parallel to or perpendicular to building planes. Conceal piping in finished areas. Install so as to require a minimum amount of furring.
- .5 Install pipe straight, parallel and close to walls and slab or deck underside, with specified pitch.
- .6 Use standard fittings for all direction changes. Do not use drilled tees and other field fabricated fittings.
- .7 Install eccentric reducers in horizontal piping to permit drainage and eliminate air pockets.
- .8 Where pipe sizes differ from connection sizes of equipment, provide reducing fittings between inline components such as valves, strainers and fittings, and equipment. Reducing bushings are not permitted.
- .9 Cap open ends of piping during installation.
- .10 Lay copper tubing so that it is not in contact with dissimilar metal and will not kink or collapse.
- .11 Use non-corrosive lubricant or teflon tape and apply on male thread.
- .12 Provide brass adaptors or dielectric couplings wherever dissimilar metals are joined.
- .13 No pipe to be laid in water or when, in opinion of Departmental Representative conditions are unsuitable.
- .14 Ensure that pipe installation does not transmit vibration to the walls and floors through which they pass.

- .15 Make provisions for neat insulation finish around equipment and materials. Do not mount equipment within insulation depth.
- .16 In electrical rooms and elevator machine rooms, provide drip trays under the entire length of all pipe within the confines of the room. Pipe drip tray to nearest floor drain.
- .17 Perform pipe welding to meet ANSI B31.9.

3.3 CONNECTIONS TO EQUIPMENT

- .1 Provide unions or flanges at all connections to equipment. Ensure that piping adjacent to equipment is readily removable for servicing and/or removal of equipment without shutting down entire system.
- .2 Install unions in piping up to and including 50 mm pipe size. Install flanges in piping 65 mm pipe size and larger.
- .3 Control valves with threaded connections are to have unions at both inlet and outlet.
- .4 Prevent galvanic corrosion by isolating copper and steel. Use red brass adapters, or completely isolate flanges using full-face gaskets with bolts installed through phenolic sleeves with insulating fibre washers. Where the Plumbing Code prohibits the use of red brass adapters, use insulating couplings. Where system valves are required, solid brass isolating valves may be used in lieu of adapters or couplings.
- .5 Provide metallic code rated continuity link between flanges or unions, where pipe mains carry flammable fluids or gases.
- .6 Make all plumbing and sheet metal connections to equipment provided by the departmental representative.

3.4 INSERTS

- .1 Size and space for the loads to be supported.
- .2 Properly locate and firmly secure inserts to forms before concrete is poured.
- .3 Place inserts only within main structure and not in any finishing materials.
- .4 When inserts are required in precast concrete, supply inserts and location drawings to the precast concrete supplier for casting into material. Otherwise, include the cost of having the precast concrete supplier install inserts at the site.
- .5 Do not use powder actuated tools.

3.5 HANGERS

- .1 Suspend piping and equipment with all necessary hangers and supports required for a safe and neat installation. Ensure that pipes are free to expand and contract and are graded properly. Adjust each hanger to take its full share of the weight.
- .2 Suspend hanger rods directly from the structure. Do not suspend pipes or equipment from other pipes, equipment, metal work, steel deck or ceilings. Fasten to the bottom rib of structural members only.
- .3 Provide auxiliary structural steel angles, channels and beams where piping and equipment must be suspended between joists or beams.

- .4 Use galvanized rods, steel support angles, channels and beams where exposed to direct contact with water or to possible high humidity conditions where condensation can occur.
- .5 Use space hangers to ensure that structural steel members are not over stressed. In no case shall pipe hangers be further apart than indicated in the tables. When requested, submit detailed drawings showing locations and magnitude of ductwork, piping and equipment loads on the structure. Provide calculations when requested by Departmental Representative. Space hangers so that point load on each hanger is no greater than 45kg. Minimum spacing of hangers to be 1220 mm on center.
- .6 Do not use trapeze type hangers for support of piping, without prior review by Departmental Representative. Where permitted, fabricate from angle or channel frames, and space hangers to suit the smallest pipe size.
- .7 Do not use hooks, chains or straps to support equipment and materials.
- .8 For precast concrete work, pass hanger rods between the members and weld to steel plates resting on the upper surface of the precast material. To prevent raising of the hanger rod, apply a lock nut and 50 mm minimum dia. flat washer tight against the under surface of the precast material.
- .9 Ensure that copper materials are completely isolated from ferrous materials. Use plastic or epoxy coated hangers and clamps. Use lead inserts between copper piping and other ferrous materials.
- .10 If individual point loads are greater than 45kg, provide a signed letter from the steel deck manufacturer confirming the deck is capable of supporting the load.
- .11 Provide round steel threaded rods meeting ASTM A-36. Provide cadmium plated rod and accessories where exposed to direct contact with water or to possible high humidity conditions where condensation can occur.

- .12 The following table establishes minimum standards of rod sizes and hanger spacing for steel and copper piping.

Maximum Horizontal Spacing of Supports			
Pipe Size mm	Rod Size mm	Steel m	Copper m
12	10	1.5	1.5
20	10	1.8	1.8
25	10	1.8	1.8
32	10	2.4	2.1
40	10	2.7	2.4
50	10	2.7	2.7
65	12	3.0	3.0
75	12	3.0	3.0
90	12	3.0	3.3
100	16	3.0	3.7
125	16	3.7	3.7
150	20	3.7	3.7
200	22	3.7	
250	22	3.7	
300	22	3.7	
350	25	3.7	
400	25	3.7	
450	29	3.7	
500	32	3.7	
600	32	3.7	

- .13 In addition to these basic requirements, provide hangers in the following location:
- .1 To eliminate vibration
 - .2 At points of vertical and horizontal change of direction of pipe
 - .3 At inline centrifugal pumps
 - .4 At valves and strainers

- .5 On mains at branch takeoffs
- .6 To avoid stress on equipment connections
- .14 Support horizontal cast iron soil pipe at each hub. Where groups of fittings occur, not more than three joints shall be between hangers.
- .15 Refer to applicable articles of the Specification regarding thermal insulation requirements. Unless shown specifically on Drawings, provide the following support methods.
 - .1 For insulated domestic hot water piping, for condensate piping and for steam piping up to 65 mm diameter, support with hangers directly on piping.
 - .2 For refrigerant and domestic cold water piping, hangers shall be large enough to fit over specified pipe covering. At each point of support, install specified protection saddles with sufficient length to prevent crushing of insulation.
- .16 Generally, support ducts with 2.7 mm by 25 mm wide galvanized hangers or with 12 mm diameter rods and 40 mm rolled angle saddles to meet SMACNA or ASHRAE Standards.
- .17 Support vertical duct risers at each floor with rolled angle collars bearing on building structure.

3.6 SLEEVES, WALL PLATES, FLOOR PLATES

- .1 Set sleeves for piping and ductwork in conjunction with erection of floors and walls. Locate sleeves accurately in accordance with submittal drawings, and as follows:
 - .1 Through interior walls, set sleeves flush with finished surfaces on both sides.
 - .2 Through exterior walls above grade, set sleeves flush with finished surfaces on inside and to suit flashing on outside.
 - .3 For floors in Mechanical Equipment Rooms, Janitors Closets, Kitchens and similar areas where a water dam is required, set sleeves flush to underside of structure and extending 50 mm above finished floor.
 - .4 For other floors, set sleeves flush to both finished surfaces. Refer to Room Finish Schedule.
- .2 Size sleeves to provide 25 mm clearance around insulated piping and ductwork.
- .3 Provide continuous insulation runs through fire separations. Ensure that piping does not touch sleeves or for domestic hot water piping terminate insulation cover on each side of sleeve. For domestic cold water piping, provide same thickness high density insulation with all purpose vapour barrier jacket through fire separation to a point 100 mm on each side of fire separation.
- .4 Install leak tight seals to meet the manufacturer's requirements. Select the inside diameter of each wall sleeve opening to fit the pipe and leak tight seal, all to ensure watertight joint.
- .5 Additional sleeving requirements:
 - .1 Provide sleeves for systems not part of Contract, but identified to be required on Drawings.
 - .2 Provide sleeves to accommodate wiring conduits required for Division 20 through 25 work.
 - .3 Provide additional sleeves as required by Drawings to accommodate service requirements. Include for the cost of drilling and setting sleeves.

- .4 Fill unused sleeves through fire separations with firestop material (see Firestopping article 3.7). Fill other unused sleeves with suitable noncombustible materials.

3.7 FIRESTOPPING

- .1 All mechanical penetrations to be firestopped by Division 07 (section 07 84 00 – firestopping)
- .2 Mechanical contractor is responsible for verifying size, type and number of locations required for mechanical systems and advising firestopping contractor.

3.8 PROVISION FOR PIPE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- .1 Make provision for pipe expansion, contraction and building shrinkage with suitable anchors and offsets or expansion loops.
- .2 Install piping to allow freedom of movement in all planes without imposing undue stress on any section of main piping, branch piping, equipment and structure.
- .3 Use offsets at takeoffs to radiation, unit heaters, fan coil units, risers and other branch lines.
- .4 Select expansion joints for the calculated movement according to the following temperature ranges.
 - .1 For cold pipes, from minimum operating temperature to 38°C), plus 25% safety factor.
 - .2 For warm and hot pipes, from minimum ambient, but not lower than -5°C, to maximum operating temperature plus 25% safety factor.
- .5 When ambient temperature during installation is higher than operating temperature, use precompressed expansion joints.
- .6 Select expansion joints to withstand system test pressure, as well as operating pressures and temperatures.
- .7 Install expansion joints in accordance with manufacturers published installation instructions.
- .8 During the construction and warranty periods, regularly review provisions for building shrinkage and make necessary adjustments to piping to ensure freedom from binding and stress.

3.9 PIPE GUIDES AND ANCHORS

- .1 Install pipe guides for expansion joints according to expansion joint manufacturer's published recommendations. Use at least two guides on each side of expansion joint.
- .2 Install manufactured or field fabricated alignment guides to allow movement in axial direction only.
- .3 Install vertical risers properly anchored and guided to maintain accurate vertical position of piping. At time of startup, clean and lubricate guides, and adjust to allow free sliding at operating conditions.
- .4 For piping up to and including 75 mm, guide pipes at every floor or every 3900 mm. Guide larger pipes at every second floor or every 7500 mm .

- .5 Fabricate anchors from structural steel channels, plates or angles.
- .6 Secure anchors to the structure. Avoid introduction of excessive reactive forces and operating weights into the structure and onto equipment and piping.
- .7 Where guides are provided on cold piping, provide thermal break to prevent sweating.

3.10 PAINTING

- .1 Supply ferrous metal work except piping and galvanized and stainless steel ductwork, with at least one factory prime coat, or paint one prime coat on job.
- .2 Clean and steel brush surfaces with welds. Then prime coat all steel supports and brackets.
- .3 On uninsulated piping, steel brush and prime coat welds.
- .4 Touchup or repaint all surfaces damaged during shipment or installation and leave ready for finish painting.
- .5 Prime coat material shall conform to Canadian General Standards Board Standard No. 1-GP-48.
- .6 Finish painting will be provided by Division 9.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:

- .1 Electrical motors, drives and guards for mechanical equipment and systems.
- .2 Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings
- .3 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V and 120V/1Ø power supply for control panels which are related to control systems specified in Division 20 through 25. Refer to Division 26 for quality of materials and workmanship.

1.2 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 SUBMITTALS

- .1 Submittals: in accordance with Section 20 04 00 - Mechanical General Requirements..
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
 - .2 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS).
- .3 Quality Control:
 - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .2 Instructions: submit manufacturer's installation instructions.
 - .1 The departmental representative will make available 1 copy of systems supplier's installation instructions.
- .4 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with applicable Provincial regulations.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.6 COMMISSIONING

- .1 Perform commissioning activities in accordance with Section 20 04 00 - Mechanical General Requirements and 01 91 13 General Commissioning Requirements.

2 Products

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
- .2 Motors under 373 W: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.
- .3 Motors 373 W and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 °C, 3 phase, 575 V, unless otherwise indicated. Motors designated for variable speed to be TEFC and inverter duty rated.

2.3 TEMPORARY MOTORS

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by the departmental representative for temporary use. Work will only be accepted when specified motor is installed.

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm diameter holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.

- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
 - .2 Securely fasten in place.
 - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.
- 3 Execution
- 3.1 MANUFACTURER'S INSTRUCTIONS
 - .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
- 3.2 INSTALLATION
 - .1 Fasten securely in place.
 - .2 Make removable for servicing, easily returned into, and positively in position.
- 3.3 FIELD QUALITY CONTROL
 - .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in Section 20 04 00 - Mechanical General Provisions.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work.
- 3.4 CLEANING
 - .1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-1.60-M89, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.2 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 10 01 – General Requirements.
- .2 Product data to include manufacturer's material description.

1.3 SUSTAINABLE DESIGN SUBMITTALS

- .1 Construction waste management plan.
 - .1 A Construction Waste Management Plan is in place to divert waste material from landfill. Wherever practical, send waste material for reuse or recycling, and generally document this for the contractor's waste management final report.
- .2 Recycled Content.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Requiring Recycled Content".
 - .2 If products within this section are indicated on the "List of Products Requiring Recycled Content", only products with recycled content will be acceptable.
 - .3 For products not identified on list, source products with highest recycled content available when practical.
 - .4 Include following information with product data submission.
 - .1 Percentage of pre-consumer and post-consumer recycled content for each product.
- .3 Regional Materials.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Required to be Locally Sourced".
 - .2 If products within this section are indicated on the "List of Products Required to be Locally Sourced", include following information with Product Data submission:
 - .1 Extraction/Manufacturing location(s): Indicate location of extraction site or manufacturing plant, and indicate distance between extraction site or manufacturing plant and Project site.
- .4 Adhesives and Sealants.
 - .1 Include following information with Product Data submission for materials specified under this section:
 - .1 Submit manufacturer's certification indicating VOC limits of Products used onsite and within the building envelope. Product shall comply with California's SCAQMD #1168.
- .5 Paints and Coatings.
 - .1 Provide low VOC Products as specified herein and complying with local regulations regarding toxic and hazardous materials.

- .2 Ensure primers, paints and coatings used onsite and within building envelope meet or exceed requirements of following standards:
 - .1 Interior and Exterior Paints: GS-11
 - .2 Anti-Corrosive Paint: GS-11
 - .3 Clear Wood Finishes and other coating not covered in GS-11: SCAQMD #1113.
 - .3 Submit manufacturer's certification indicating VOC limits of Products.
 - .6 If requesting substitute product, ensure proposed substitution achieves above stated goals.
- 1.4 MAX. VOC CONTENT FOR SOLVENT CLEANING ACTIVITIES
 - .1 Following are some of the Maximum allowed VOC Content for following activities, as per SCAQMD Rule 1171-9 (refer to SCAQMD manual for complete list and updates):
 - .1 Product cleaning during onsite surface preparation for coatings or adhesives application, and repair and maintenance cleaning:
 - .1 General maximum VOC 25g/L.
 - .2 Electrical apparatus components and electronic components.
 - .3 Cleaning of coatings or adhesives application equipment max. VOC 25g/L.
 - .2 Refer to SCAQMD for additional information and clarification and complete list of applications.
 - .3 Any discrepancies are to be approved by Departmental Representative. Obtain written approval prior to use on site.
- 2 Products
 - 2.1 MANUFACTURER'S EQUIPMENT PLATES
 - .1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.
 - .2 Lettering and numbers to be raised or recessed.
 - .3 Information to include, as appropriate:
 - .1 Equipment: Manufacturer's name, model, size, serial number, capacity, date.
 - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.
 - 2.2 SYSTEM NAMEPLATES
 - .1 Colours:
 - .1 Hazardous: red letters, white background.
 - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
 - .2 Construction:
 - .1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.
 - .3 Sizes:
 - .1 Conform to following table:

Size #	Dimensions (mm x mm)	No. of Lines	Letter Height (mm)
1	9 x 50	1	3
2	12 x 75	1	5
3	12 x 75	2	3
4	19 x 100	1	8
5	19 x 100	1	8
6	19 x 100	2	5
7	25 x 125	1	12
8	25 x 125	2	8
9	40 x 100	1	19

- .2 Use maximum of 25 letters/numbers per line.
- .3 Terminal cabinets, control panels: Use size #6.
- .4 Equipment in Mechanical Rooms: Use size #9.
- .5 Reheat coils, fans, etc., located above suspended ceilings to be identified via nameplates secured to the room side of the T-bar grid or drywall ceiling access door directly below the applicable equipment: Use size #6.

2.3 IDENTIFICATION OF PIPING SYSTEMS (EXISTING AND NEW SYSTEMS)

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
- .2 Pictograms:
 - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 All other pipes: Pressure sensitive plastic-coated cloth with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C and intermittent temperature of 200°C.

.7 Colours and Legends:

- .1 Where not listed, obtain direction from the departmental representative.
- .2 Colours for legends, arrows: The following table is provided as an example, Contractor shall coordinate with the departmental representative to match existing identification used in the existing facility:

Background Color	Legend, Arrows
Yellow	Black
Green	White
Red	White

- .3 Background colour marking and legends for piping systems: The following table is provided as an example. The Contractor shall coordinate with the departmental representative to match existing identification used in the existing facility:

Contents Marking	Background Color	Legend
Domestic hot water	Green	DHW
Domestic hot water return	Green	DHWR
Domestic cold water	Green	DCW
Sanitary	Green	SAN
Sanitary Vent	Green	SAN VENT
VRF Condensate Drain	Green	COND. DRAIN
Humidification Steam	Yellow	HUM. STM
Humidification Condensate	Yellow	HUM. COND
Refrigeration suction	Yellow	RS
Refrigeration liquid	Yellow	RL
Sprinkler	Red	---
Radon Extraction System	Red	RADON VENT SYSTEM

2.4 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.

2.5 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.

- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.
- 2.6 CONTROLS COMPONENTS IDENTIFICATION
- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
 - .2 Inscriptions to include function and (where appropriate) fail-safe position.
- 2.7 LANGUAGE
- .1 Identification to be in English.
- 3 Execution
- 3.1 TIMING
- .1 Provide identification only after all painting specified Section 09 91 23 - Painting has been completed.
- 3.2 INSTALLATION
- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
 - .2 Provide ULC and or CSA registration plates as required by respective agency.
- 3.3 NAMEPLATES
- .1 Locations:
 - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
 - .2 Standoffs:
 - .1 Provide for nameplates on hot and/or insulated surfaces.
 - .3 Protection
 - .1 Do not paint, insulate or cover in any way.
- 3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS
- .1 On long straight runs in open areas, equipment rooms, galleries, tunnels: At not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
 - .2 Adjacent to each change in direction.
 - .3 At least once in each small room through which piping or ductwork passes.
 - .4 On both sides of visual obstruction or where run is difficult to follow.
 - .5 On both sides of separations such as walls, floors, partitions.
 - .6 Where system is installed in pipe chases, ceiling spaces, galleries, other confined spaces, at entry and exit points, and at each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in run.

- .8 At point immediately upstream of major manually operated or automatically controlled valves, dampers, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .9 Identification to be easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.

3.5 VALVES, CONTROLLERS

- .1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by the departmental representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

END OF SECTION

1 General

1.1 GENERAL

- .1 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do all other work as specified in this section.

1.2 PURPOSE OF TAB

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads
- .2 Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.3 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of the departmental representative.

1.4 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.5 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to the departmental representative adequacy of provisions for TAB and all other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to the departmental representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of all TAB devices, equipment, accessories, measurement ports and fittings.

1.6 START-UP

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

1.7 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by the departmental representative for verification of TAB reports.

1.8 START OF TAB

- .1 Notify the departmental representative 7 days prior to start of TAB.
- .2 Start TAB only when building is essentially completed, including:
 - .1 Installation of ceilings, doors, windows, other construction affecting TAB.
 - .2 Application of weatherstripping, sealing, caulking.
 - .3 All pressure, leakage, other tests specified elsewhere Division 23.
 - .4 All provisions for TAB installed and operational.
 - .5 Start-up, verification for proper, normal and safe operation of all mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 All outlets installed, volume control dampers open.
 - .3 Liquid Systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.

1.9 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus or minus 10%.
 - .2 Plumbing Domestic Hot Water Recirc System: plus or minus 10%.

1.10 ACCURACY TOLERANCES

- .1 Measured values to be accurate to within plus or minus 2% of actual values.

1.11 SUBMITTALS

- .1 Submit, prior to commencement of TAB:
 - .1 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.12 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of the departmental representative prior to submission of formal TAB report, sample of rough TAB sheets. Include:
 - .1 Details of instruments used.
 - .2 Details of TAB procedures employed.
 - .3 Calculations procedures.

.4 Summaries.

1.13 TAB REPORT

- .1 Format to be in accordance with referenced standard.
- .2 TAB report to show all results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
 - .3 Submit 3 hard copies and one electronic of the final TAB Report to the departmental representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.14 VERIFICATION

- .1 All reported results subject to verification by the departmental representative.
- .2 Provide manpower and instrumentation to verify up to 100% of all reported results.
- .3 Number and location of verified results to be at discretion of the departmental representative.
- .4 Bear costs to repeat TAB as required to satisfaction of the departmental representative.

1.15 SETTINGS

- .1 After TAB is completed to satisfaction of the departmental representative, replace drive guards, close all access doors, lock all devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark all settings to allow restoration at any time during life of facility. Markings not to be eradicated or covered in any way.

1.16 COMPLETION OF TAB

- .1 TAB to be considered complete only when final TAB Report received and approved by the departmental representative.

1.17 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or SMACNA or ASHRAE.
- .2 Do TAB of all systems, equipment, components, and controls specified in Division 20 through 25.
- .3 Qualifications: Personnel performing TAB to be current member in good standing of AABC and NEBB.
- .4 Quality Assurance: Perform TAB under direction of supervisor qualified to standards of AABC and NEBB.
- .5 Measurements: To include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

- .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
 - .3 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).

1.18 DHW CIRCULATION SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or SMACNA or ASHRAE.
- .2 Do TAB of all systems, equipment, components, and controls specified in Division 20 through 25.
- .3 Qualifications: Personnel performing TAB to be current member in good standing of AABC or NEBB qualified to standards of AABC or NEBB.
- .4 Quality Assurance: Perform TAB under direction of supervisor qualified to standards of AABC and NEBB.
- .5 Measurements: To include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperatures, density, specific gravity, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include, but not be limited to, following as appropriate: Inlet and outlet of each pump.
- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main, main branch.

2 Products

2.1 Not Used.

3 Execution

3.1 Not Used.

END OF SECTION

1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM).
 - .1 ASTM A167-89a, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
 - .2 ASTM C335-89, Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulations.
 - .3 ASTM C411-82(1987), Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .2 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S102-M88, Surface Burning Characteristics of Building Materials and Assemblies.
- .3 National Fire Protection Association (NFPA).
 - .1 ANSI/NFPA 90A-1989, Installation of Air Conditioning and Ventilating Systems.
 - .2 ANSI/NFPA 90B-1989, Installation of Warm Air Heating and Air Conditioning Systems.
- .4 Canadian General Standards Board (CGSB).
 - .1 CGSB 51-GP-9M-76, Thermal Insulation, Mineral Fibre, Sleeving for Piping and Round Ducting.
 - .2 CGSB 51-GP-11M-76, Thermal Insulation, Mineral Fibre, Blanket for Piping, Ducting, Machinery and Boilers.
 - .3 CAN/CGSB-51.12-M86, Cement, Thermal Insulating and Finishing.
 - .4 CAN/CGSB-51.40-M80, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
 - .5 CGSB 51-GP-52Ma-89, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .6 CGSB 51-GP-53M-77, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .5 Canadian Standards Association (CSA).
 - .1 CSA HA Series-M1980, CSA Standards for Aluminum and Aluminum Alloys.
- .6 Thermal Insulation Association of Canada (TIAC).
 - .1 TIAC, Thermal Insulation Association of Canada, National Insulation Standards.

1.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 10 01 - General Requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

1.3 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
 - .2 "EXPOSED" - will mean "not concealed" as defined herein.

1.4 SUSTAINABLE DESIGN SUBMITTALS

- .1 Construction waste management plan.
 - .1 A Construction Waste Management Plan is in place to divert waste material from landfill. Wherever practical, send waste material for reuse or recycling, and generally document this for the contractor's waste management final report.
- .2 Recycled Content.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Requiring Recycled Content".
 - .2 If products within this section are indicated on the "List of Products Requiring Recycled Content", only products with recycled content will be acceptable.
 - .3 For products not identified on list, source products with highest recycled content available when practical.
 - .4 Include following information with product data submission.
 - .1 Percentage of pre-consumer and post-consumer recycled content for each product.
- .3 Regional Materials.
 - .1 Refer to Section 01 47 15 - Sustainable Requirements for "List of Products Required to be Locally Sourced".
 - .2 If products within this section are indicated on the "List of Products Required to be Locally Sourced", include following information with Product Data submission:
 - .1 Extraction/Manufacturing location(s): Indicate location of extraction site or manufacturing plant, and indicate distance between extraction site or manufacturing plant and Project site.
- .4 Adhesives and Sealants.
 - .1 Include following information with Product Data submission for materials specified under this section:
 - .1 Submit manufacturer's certification indicating VOC limits of Products used onsite and within the building envelope. Product shall comply with California's SCAQMD #1168.
- .5 Paints and Coatings.
 - .1 Provide low VOC Products as specified herein and complying with local regulations regarding toxic and hazardous materials.
 - .2 Ensure primers, paints and coatings used onsite and within building envelope meet or exceed requirements of following standards:
 - .1 Interior and Exterior Paints: GS-11
 - .2 Anti-Corrosive Paint: GS-11
 - .3 Clear Wood Finishes and other coating not covered in GS-11: SCAQMD #1113.
 - .3 Submit manufacturer's certification indicating VOC limits of Products.
- .6 If requesting substitute product, ensure proposed substitution achieves above stated goals.

1.5 MAX. VOC CONTENT FOR SOLVENT CLEANING ACTIVITIES

- .1 Following are some of the Maximum allowed VOC Content for following activities, as per SCAQMD Rule 1171-9 (refer to SCAQMD manual for complete list and updates):
 - .1 Product cleaning during onsite surface preparation for coatings or adhesives application, and repair and maintenance cleaning:
 - .1 General maximum VOC 25g/L.
 - .2 Electrical apparatus components and electronic components.
 - .3 Cleaning of coatings or adhesives application equipment max. VOC 25g/L.
 - .2 Refer to SCAQMD for additional information and clarification and complete list of applications.
 - .3 Any discrepancies are to be approved by Departmental Representative. Obtain written approval prior to use on site.

2 Products

2.1 GENERAL

- .1 Components of insulation system to have maximum flame spread rating of 25 and maximum smoke developed rating of 50 in accordance with CAN/ULC-S102.
- .2 Materials to be tested in accordance with ASTM C411.
- .3 Temperatures listed for fluid are approximate. Verify final operating temperatures and apply thicknesses as listed under relevant insulation type.

2.2 P-1 FORMED MINERAL FIBER TO 205°C

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic hot water, temperature 60°C.
 - .2 Domestic hot water recirculation, temperature 60°C.
 - .1 Humidifier distributor and condensate piping and drains, temperature 100°C.
- .2 Materials:
 - .1 CGSB 51-GP-9M, rigid mineral fiber sleeving for piping.
 - .2 Standard of Acceptance: Manville Micro-lok; Manson Alley K; Knauf pipe insulation; Owens Corning SSLII jacketed pipe insulation.
 - .3 Thermal Conductivity "k" shall not exceed 0.034 W/m.°C at 24°C mean temperature when tested in accordance with ASTM C335. Thickness:

.4

Fluid Temperature °C	Nominal Pipe Sizes (NPS) thickness (mm)			
	1 and under	1-1/4-2	2-1/2-4	5 & Over
151-200	64	64	76	89
121-150	51	64	64	76
96-120	38	38	51	51
51-95	25	25	38	38
30-50	25	25	25	25
Condensate Returns	25	38	51	51

2.3 P-2 FORMED MINERAL FIBER WITH VAPOUR BARRIER TO 85°C

- .1 Application: for piping, valves and fittings on:
 - .1 Domestic cold water, temperature 4°C.
 - .2 Air conditioner drains, temperature 5°C.
 - .3 Air intake plenum drains, temperature 4°C.
- .2 Material:
 - .1 CGSB 51-GP-9M, rigid mineral fiber sleeving for piping and CGSB 51-GP-52Ma, vapour barrier jacket and facing material.
 - .2 Standard of Acceptance: Manville Micro-lok-AP-T Plus; Manson Alley K-APT; Knauf 454°C pipe insulation with ASJ; Owens Corning SSLII jacketed pipe insulation.
 - .3 Thermal Conductivity "k" shall not exceed 0.034 W/m.°C at 24°C mean temperature when tested in accordance with ASTM C335. Thickness:

Fluid Temperature °C	Nominal Pipe Sizes (NPS) thickness (mm)			
	1 and under	1-1/4-2	2-1/2-4	5 & Over
51-85	25	25	38	38
30-50	25	25	25	25
5-29	13	25	25	25
below 5	25	38	38	38

2.4 P-3 FLEXIBLE ELASTOMERIC -40°C TO 100°C

- .1 Application: for piping, valves and fittings in building exposed and concealed, and above ground outdoors:
 - .1 Refrigeration suction lines and liquid lines.
- .2 Material:
 - .1 CAN/CGSB-51.40, flexible elastomeric unicellular sheet and pipe covering.
 - .2 Standard of Acceptance: RBX Industries Inc. Rubatex R-180-FS; Armstrong AP Armaflex.
- .3 Thickness:

Line Size Nominal	Thickness Nominal
NPS 1½ and under	13 mm
NPS 2 to 3	20 mm
NPS 3 to 6	25 mm

2.5 FASTENINGS

- .1 For insulation systems P-1, P-2.
 - .1 Tape: self adhesive, ULC labelled for less than 25 flame spread and less than 50 smoke developed.
 - .2 Standard of Acceptance: Fattal Insultape; Venture Tape.
 - .3 Lap seal adhesive: quick-setting for joints and lap sealing of vapour barriers.
 - .4 Acceptable Material: Foster 87-75 asbestos free at 6 m²/L; Childers CP.80; Bakelite 230-06.
 - .5 Lagging adhesive: fire retardant coating.
 - .6 Standard of Acceptance: Foster 30-36 asbestos free at 1.25 m²/L; Childers CP.50A-HV2; Bakor 120-09.
- .2 For insulation system P-3.
 - .1 Contact adhesive: quick-setting for seams and joints.
 - .2 Tape: self adhesive PVC.
 - .3 Acceptable material: Foster 85-20 asbestos free at 5 m²/L; Childers CP-82; Bakor 230-06; Armstrong 520 adhesive; RBX Industries Inc. R-320 Adhesive.

2.6 INSULATION CEMENT

- .1 To CAN/CGSB-51.12.

2.7 JACKETS

- .1 PVC.
- .2 Apply in accordance with CGSB 51-GP-53M.
- .3 0.38 mm thick minimum.
- .4 Valve and fittings covers, one piece, pre-moulded to match.
- .5 Roll or "cut and curled" form at discretion of installer.

- .6 Secure with solvent weld to recommendations of manufacturer.
- .7 Apply PVC jacket and fitting covers to all exposed piping.
- .8 For outdoor applications, PVC jackets to be 1.0 mm thick minimum, UV and impact resistant.
- .9 Standard of Acceptance: Manville Zeston, Kauf Proto.

3 Execution

3.1 APPLICATION

- .1 Apply insulation after required tests have been completed and approved by the departmental representative.
- .2 Surfaces shall be clean and dry during application of insulation and finishes.
- .3 Apply insulation materials, accessories and finishes in accordance with TIAC National Insulation Standards and manufacturer's recommendations and as specified herein.
- .4 On piping with insulation and vapour barrier, install high density insulation under hanger shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports.
- .5 Terminate insulation and each side of fire wall and seal insulation to all service jacket and to fire wall after fire stopping has been completed.

3.2 INSTALLATION

- .1 Preformed: sectional up to NPS 12, sectional or curved segmented above NPS 12.
- .2 Multi-layered: staggered butt joint construction.
- .3 Vertical pipe over NPS 3: insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 4.5 m centres.
- .4 Expansion joints in insulation: terminate single layer and each layer of multiple layers in straight cut at intervals recommended by manufacturer. Leave void of 25 mm between terminations. Pack void lightly with flexible mineral insulation.
- .5 Seal and finish exposed ends and other terminations with insulating cement.
- .6 Expansion joints in piping: provide for adequate movement of expansion joint without damage to insulation or finishes.
- .7 At flanges and unions at equipment, expansion joints, valves, circuit balancing and service and other components requiring regular maintenance: omit insulation and bevel away from studs and nuts to permit use of tools without damage to insulation.
- .8 Insulation is not required for:
 - .1 Chrome plated piping, valves and fittings.
 - .2 Drain Valves.

3.3 FASTENINGS

- .1 Secure pipe insulation by tape at each end and centre of each section, but not greater than 900 mm on centres.

END OF SECTION

1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E 202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 POTABLE WATER SYSTEMS

- .1 When cleaning is completed and system filled:
 - .1 Verify performance of equipment and systems as specified elsewhere in Division 20 through 25.
 - .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut off water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
 - .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.3 SANITARY AND STORM DRAINAGE SYSTEMS

- .1 Buried systems: perform tests prior to back-filling. Perform hydraulic tests to verify grades and ball test to confirm freedom from obstructions.
- .2 Ensure that traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system.
- .4 Operate flush valves, tank and operate each fixture to verify drainage and no leakage.

1.4 COMMISSIONING

- .1 Perform commissioning activities in accordance with section 20 04 00 - Mechanical General Requirements.

2 Products

2.1 Not Used

3 Execution

3.1 Not Used

END OF SECTION