

NATIONAL CAPITAL COMMISSION KITCHEN HVAC UPGRADE PROJECT NO. DC 1110-19

SPECIFICATION Issued for Tender

Prepared by:



GOODKEY, WEEDMARK & ASSOCIATES LIMITED

1688 Woodward Drive

Ottawa, Ontario

K2C 3R8

Tel: 613-727-5111

Fax: 613-727-5115

GWA 2013-499

December 15, 2014



DRAWINGS

A0 – COVER SHEET

A1 – GROUND FLOOR PLAN

A2 – FIRST FLOOR PLAN

A3 – SECOND FLOOR PLAN

A4 – CROSS-SECTION DETAIL

A5 – ELEVATION DETAILS

A6 – DETAILS

A7 – DETAILS

E001 – ELECTRICAL LEGENDS, DRAWING LIST AND KEY PLANS

E100 – GROUND FLOOR DEMOLITION AND NEW WORK

E101 – FIRST FLOOR DEMOLITION AND NEW WORK

E102 – SECOND FLOOR DEMOLITION AND NEW WORK

M001 – MECHANICAL DRAWING LIST AND LEGENDS

M002 – MECHANICAL SCHEDULES

M003 – MECHANICAL DETAILS

M004 – MECHANICAL DETAILS

M100 – MECHANICAL GROUND FLOOR FIRE PROTECTION & PLUMBING DEMOLITION & NEW WORK

M101 – MECHANICAL FIRST FLOOR FIRE PROTECTION & PLUMBING DEMOLITION & NEW WORK

M102 – MECHANICAL SECOND FLOOR FIRE PROTECTION & PLUMBING DEMOLITION & NEW WORK

M200 – MECHANICAL GROUND FLOOR PLUMBING & UTILITIES DEMOLITION & NEW WORK

M201 – MECHANICAL SECOND FLOOR UTILITIES DEMOLITION & NEW WORK

M300 – MECHANICAL GROUND FLOOR HVAC DEMOLITION & NEW WORK

M301 – MECHANICAL FIRST FLOOR HVAC NEW WORK

M302 – MECHANICAL SECOND FLOOR HVAC DEMOLITION & NEW WORK

S001 – PLANS, NOTES AND DETAILS

S002 – PLANS AND DETAILS

SPECIFICATIONS

<u>Section</u>	<u>Title</u>	<u>Pages</u>
<u>Division 05 - Metals</u>		
05 12 23	STRUCTURAL STEEL FOR BUILDINGS	4
<u>Division 06 - Wood, Plastics and Composites</u>		
06 10 00	ROUGH CARPENTRY	5
<u>Division 07 - Thermal and Moisture Protection</u>		
07 52 00	MODIFIED BITUMINOUS MEMBRANE ROOFING	8
07 84 00	FIRE STOPPING	6
07 92 00	JOINT SEALANT	4
<u>Division 08 - Openings</u>		
08 31 00.01	ACCESS DOORS – MECHANICAL	2
<u>Division 09 – Finishes</u>		
09 21 16	GYPSUM BOARD ASSEMBLIES	5
09 65 16	RESILIENT SHEET FLOORING	4
09 91 23	PAINTING FOR MINOR WORKS	6

SPECIFICATIONS (CONT'D)

<u>Section</u>	<u>Title</u>	<u>Pages</u>
<u>Division 21 - Fire Suppression</u>		
21 05 00	MECHANICAL GENERAL REQUIREMENTS	7
21 13 13	WET PIPE SPRINKLER SYSTEMS	3
<u>Division 22 - Plumbing</u>		
22 11 16	DOMESTIC WATER PIPING	3
22 13 18	DRAINAGE WASTE AND VENT PIPING - PLASTIC	3
22 42 01	PLUMBING SPECIALTIES AND ACCESSORIES	4
22 42 03	PLUMBING FIXTURES AND TRIM	3
<u>Division 23 - Heating, Ventilating and Air-Conditioning (HVAC)</u>		
23 05 05	INSTALLATION OF PIPEWORK	4
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	3
23 05 14	VARIABLE FREQUENCY DRIVES	7
23 05 16	EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING	2
23 05 17	WELDING	3
23 05 19.01	THERMOMETERS AND PRESSURE GAUGES - PIPING SYSTEMS	2
23 05 23.01	VALVES	4
23 05 29	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT	4
23 05 48	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT	3
23 05 53.01	MECHANICAL IDENTIFICATION	3
23 05 93	TESTING, ADJUSTING AND BALANCING FOR HVAC	5
23 07 13	DUCT INSULATION	5
23 07 15	THERMAL INSULATION FOR PIPING	4
23 08 02	CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS	3
23 11 23	FACILITY NATURAL GAS PIPING	3
23 21 13.01	HYDRONIC SYSTEMS: COPPER	3
23 21 13.02	HYDRONIC SYSTEMS: STEEL	3
23 21 14	HYDRONIC SPECIALTIES	4
23 21 23	HYDRONIC PUMP	3
23 31 13.01	METAL DUCTS - LOW PRESSURE TO 500 PA	4
23 32 48	ACOUSTICAL DUCT LINING	2
23 33 00	AIR DUCT ACCESSORIES	2
23 33 14	DAMPERS - BALANCING	2
23 33 15	DAMPERS - OPERATING	2
23 33 16	DAMPERS - FIRE AND SMOKE	3
23 34 00	HVAC FANS	4
23 57 00	HEAT EXCHANGERS FOR HVAC	2
23 73 11	AIR HANDLING UNITS - PACKAGED	7
23 73 14	MAKE-UP AIR UNIT (MUA)	7
<u>Division 25 - Integrated Automation</u>		
25 01 11	EMCS: START-UP, VERIFICATION AND COMMISSIONING	4
25 05 01	EMCS: GENERAL REQUIREMENTS	4
25 30 02	EMCS: FIELD CONTROL DEVICES	6
25 90 01	EMCS: SITE REQUIREMENTS, APPLICATIONS AND SYSTEMS SEQUENCES OF	3

SPECIFICATIONS (CONT'D)

<u>Section</u>	<u>Title</u>	
<u>Division 26 - Electrical</u>		
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL	7
26 05 05	SEISMIC RESTRAINT SYSTEMS (SRS)	4
26 05 20	WIRE AND BOX CONNECTORS (0-1000 V)	1
26 05 21	WIRES AND CABLES (0-1000 V)	2
26 05 28	GROUNDING - SECONDARY	2
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	1
26 05 31	SPLITTERS, JUNCTION, PULL BOXES AND CABINETS	2
26 05 32	OUTLET BOXES, CONDUIT BOXES AND FITTINGS	2
26 05 34	CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS	3
26 27 26	WIRING DEVICES	2
26 28 16.02	MOULDED CASE CIRCUIT BREAKERS	1
26 28 23	DISCONNECT SWITCHES - FUSED AND NON-FUSED	2
26 29 10	MOTOR STARTERS TO 600 V	2
26 50 00	LIGHTING	2
<u>Division 28 - Electronic Safety and Security</u>		
28 31 00.01	MULTIPLEX FIRE ALARM SYSTEM	2

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM International Inc.)
 - .1 ASTM A325 09, Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA G40.20/G40.21 04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA S16 09, Design of Steel Structures.
 - .3 CSA W47.1 09, Certification of Companies for Fusion Welding of Steel.
 - .4 CSA W48 06, Filler Metals and Allied Materials for Metal Arc Welding.
 - .5 CSA W59 03 (R2008), Welded Steel Construction (Metal Arc Welding).

1.2 SUBSTITUTIONS

- .1 Submit all proposals for substitutions to the Departmental Representative in writing in advance of shop drawings. Each item shall be clearly identified. Do not proceed with the substitution unless it is accepted in writing.
- .2 Sections shown are the lightest weight required for the applied loading. Substitutions of alternat be allowed provided the new members have equal or greater capacity and stiffness and are of dimensions acceptable at that location. Clearly identify all substitutions on shop drawings.

1.3 SCHEDULING

- .1 .1 Schedule fabrication and erection as required to meet reviewed progress schedule. Allow ample co-ordination time for galvanized finish, specified shop prime, etc.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Erection drawings:
 - .1 Submit erection drawings indicating material specifications, details and information necessary for assembly and erection purposes including:
 - .1 Description of methods.
 - .2 Sequence of erection.
 - .3 Type of equipment used in erection.
 - .4 Temporary bracings.
- .2 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, components and connections, including temporary shoring details and erection procedures for all structural steel.
- .3 Qualifications:
 - .1 Work shall be carried out by a member of the Canadian Institute of Steel Construction.
 - .2 Welding shall be performed by individual welders, and by firms fully approved by the Canadian Welding Bureau under the requirements of CSA W47.1 and where applicable CSA W55.3.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Conform to the following:
 - .1 Store all metal above ground on platforms or skids; above snow or mud.
 - .2 Protect from moisture and corrosion until erected.
 - .3 Store and protect paint materials as recommended by manufacturer.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Divert unused paint material from landfill to official hazardous material collections site.

1.6 SITE CONDITIONS

- .1 Visit site to check on available access, storage, and working areas. Determine any interference with existing services.
- .2 Make all field measurements necessary to ensure the proper fit of all members.
- .3 Identify main shop drawing dimensions which have been obtained by field measurement.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Structural steel: to CSA G40.20/G40.21 Grade 300W and/or CSA-S136, except rolled W-Sections Grade 350W, and Hollow Structural Sections Grade 350W Class C. Column steel must conform to Canadian Standard. For all other steel, substitution to ASTM A500, Grade C (Fy=345 MPa) is acceptable.
- .2 Structural bolts, nuts and washers: to ASTM A325.
- .3 Welding materials: to CSA W59 and certified by Canadian Welding Bureau.
- .4 Shop paint primer: red oxide or grey, fast curing, lead and chromate free, universal modified alkyd

2.2 FABRICATION

- .1 Fabricate structural steel in accordance with CSA S16 and in accordance with reviewed shop drawings.

2.3 SHOP PAINTING

- .1 Clean, prepare surfaces and shop prime structural steel in accordance with CSA S16.
- .2 Clean surfaces of steel and welds of chemical residue and flux left by electrodes.
- .3 Apply two coats of primer in the shop to all steel surfaces, to achieve minimum dry film thickness 0.05mm (1.5) to (2) mils except:
 - .1 Surfaces and edges to be field welded for a distance of 50 mm from the joint.
 - .2 Surfaces fireproofed by spraying, where non-compatible with paint.
 - .3 Where otherwise noted on drawings.
- .4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C, in accordance with paint manufacturer's instructions.

- .5 Apply paint to architecturally exposed surfaces without runs or sags. Sand down and repaint areas acceptable to the Departmental Representative.
- .6 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.
- .7 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.
- .8 Apply touch up paint after erection to all areas which have been missed, scraped or chipped using t paint as the shop coat or primer including bolts and welds preceded by thorough cleaning.

PART 3 - EXECUTION

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product bulletins, handling, storage and installation instructions, and datasheets.

3.2 GENERAL

- .1 Structural steel work: in accordance with CSA S16.
- .2 Welding: in accordance with CSA W59.

3.3 PREPARATION

- .1 Protection of Existing Structure
 - .1 Take precautions necessary to protect the existing structure from damage. The contractor shall be responsible for damage and claims for damage.
- .2 Demolition
 - .1 Dismantle structural steel in the areas noted on the Drawings under the work of this Section.
 - .2 Dismantled steel shall become the property of the Contractor. Remove from site.
- .3 Connection to Existing Work
 - .1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to Departmental Representative for direction before commencing fabrication.

3.4 ERECTION/INSTALLATION

- .1 Alterations to Existing Structure
 - .1 Provide all structural steel erected in place required within the existing building.
 - .2 Do all cutting of existing structural steel where indicated. Provide connections and extensions to existing steel as required.
 - .3 Provide temporary shoring and bracing required for these operations. Provide fire watch during all cutting and welding operations.
 - .4 Remove and dispose of from site, existing steel which is dismantled but not designated for reuse. It shall become the property of the Contractor.
- .2 Erection
 - .1 Erect structural steel, as indicated and in accordance with CSA S16 and in accordance with reviewed erection drawings.
 - .2 Field cutting or altering structural members: to approval of Departmental Representative.

- .3 Make adequate provision for all loads acting on the structure during erection. Provide temporary bracing to keep the structure stable, plumb and in true alignment during construction. Any bracing members or connections shown on the plans are those required for the finished structure, and may not be sufficient for erection purposes. Such additional temporary bracing as may be required is the responsibility of the Contractor.
 - .4 Do not make permanent connections until as much of the structure as will be stiffened thereby has been properly aligned.
 - .5 Report ill-fitting connections to the Departmental Representative before taking corrective measures.
 - .6 Do not weld in an ambient temperature below -17 degrees C. Preheat material adjacent to welding areas when ambient temperature is between -17 degrees C and +4 degrees C.
 - .7 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.
- .3 Tolerances
- .1 Fabrication and erection tolerances to meet the requirements of CSA S16.
 - .2 In addition where glazing is attached directly to the steel frame, the maximum tolerance for any dimension affecting glazing shall be plus or minus 3mm (1/8 in).

3.5 FIELD QUALITY CONTROL

- .1 Inspection and testing of welded and bolted connections will be carried out by testing agency desi Departmental Representative.
- .2 Provide safe access and working areas for testing on site, as required by testing agency and as aut Departmental Representative.
- .3 Arrange for the inspector to complete field inspection as soon as each section of the erection wor completed, and all bolts tightened. Submit test reports to Departmental Representative within 2 weeks of completion of inspection.
- .4 Departmental Representative will pay costs of tests.
- .5 Inspection agency will be an organization certified by the Canadian Welding Bureau to CSA W178 for methods specified.
- .6 Inspection will include:
 - .1 Ensuring that fabrication and erection procedures conform to the requirements of the Specification.
 - .2 Checking of welders' CWB Certification.
 - .3 Checking fabricated members against specified member shapes.
 - .4 Inspection of all welded connections including spot checking of joint preparation and fit-up.
 - .5 Checking of bolted joints.
 - .6 Checking that tolerances are not exceeded during erection or during fit-up of field welded joints.
 - .7 Inspection of field cutting and alteration.
 - .8 Shop paint and field touch-up.

- END OF SECTION -

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Read and be governed by conditions of the contract and sections of Division 1.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A123/A123M- 09, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A653/A653M- 09a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealloyed) by the Hot-Dip Process.
 - .3 ASTM C1396/C1396M-09a, Standard Specification for Gypsum Board.
 - .4 ASTM D1761-06, Standard Test Methods for Mechanical Fasteners in Wood.
 - .5 ASTM D5456-10, Standard Specification for Evaluation of Structural Composite Lumber Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction and amendment.
 - .2 CAN/CGSB-71.26-M88, Adhesive for Field-Gluing Plywood to Lumber Framing for Floor Systems.
- .3 CSA International
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .2 CSA O112 Series-M1977(R2006), CSA Standards for Wood Adhesives.
 - .3 CSA O121-08, Douglas Fir Plywood.
 - .4 CSA O141-05(R2009), Softwood Lumber.
 - .5 CSA O151-09, Canadian Softwood Plywood.
 - .6 CSA O153-M1980(R2008), Poplar Plywood.
 - .7 CSA O325-07, Construction Sheathing.
 - .8 CSA O437 Series-93(R2006), Standards on OSB and Waferboard.
- .4 Forest Stewardship Council (FSC)
 - .1 FSC-STD-01-001-2004, FSC Principle and Criteria for Forest Stewardship.
 - .2 FSC-STD-20-002-2004, Structure and Content of Forest Stewardship Standards V2-1
 - .3 FSC Accredited Certified Bodies.
- .5 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber 2007.
- .6 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for wood products and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 QUALITY CONTROL

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood, particleboard, OSB and wood based composite panels in accordance with CSA and ANSI standards.
- .3 Sustainable Standards Certification:
 - .1 Certified Wood: submit listing of wood products and materials used in accordance with FSC-STD-01-001.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wood from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section.

Part 2 Products

2.1 FRAMING STRUCTURAL AND PANEL MATERIALS

- .1 Description:
 - .1 Sustainability Characteristics:
 - .1 Lumber, SCL, FSC Certified.
 - .2 Plywood, particleboard, OSB, urea-formaldehyde free, FSC Certified.
- .2 Lumber: softwood, S4S, moisture content 19% (S-dry) or less in accordance with following standards:
 - .1 CSA O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
- .3 Structural Composite Lumber (SCL) in accordance with ASTM D5456.
- .4 Framing and board lumber: in accordance with NBC.
- .5 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:

- .1 S2S is acceptable for concealed locations.
- .2 Board sizes: "Standard" or better grade.
- .3 Dimension sizes: "Standard" light framing or better grade.
- .4 Post and timbers sizes: "Standard" or better grade.
- .6 Plywood, OSB and wood based composite panels: to CSA O325.
- .7 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .8 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .9 Poplar plywood (PP): to CSA O153, standard construction.

2.2 ACCESSORIES

- .1 Exterior wall sheathing paper: to CAN/CGSB-51.32
- .2 Polyethylene film: to CAN/CGSB-51.34, Type 1, 0.15 mm thick.
- .3 Air seal: closed cell polyurethane or polyethylene.
- .4 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 Sealants: VOC limit 250 g/L maximum to SCAQMD Rule 1168.
- .5 Subflooring adhesive: to CAN/CGSB-71.26, cartridge loaded.
 - .1 Adhesives: VOC limit 120 g/L maximum to SCAQMD Rule 1168.
- .6 General purpose adhesive: to CSA O112 Series.
 - .1 VOC limit 70 g/L maximum to SCAQMD Rule 1168.
- .7 Nails, spikes and staples: to CSA B111.
- .8 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .9 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, recommended for purpose by manufacturer.
- .10 Joist hangers: minimum 1 mm thick sheet steel, galvanized ZF001 coating designation.
- .11 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal, formed to prevent dishing. Bell or cup shapes not acceptable.
- .12 Roof sheathing H-Clips: formed "H" shape, thickness to suit panel material, type approved by NCC Engineer.
- .13 Fastener Finishes:
 - .1 Galvanizing: to ASTM A123/A123M, use galvanized fasteners for exterior work, interior highly humid areas, pressure-preservative treated lumber.
- .14 Wood Preservative:
 - .1 Preservative: in accordance with manufacturer's recommendations for surface conditions:
 - .1 Preservative: VOC limit 350 g/L maximum to SCAQMD Rule 1113.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for product installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of NCC Representative.
 - .2 Inform NCC Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NCC Representative.

3.2 PREPARATION

- .1 Treat surfaces of material with wood preservative, before installation.
- .2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Treat material as follows:
 - .1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.
 - .2 Wood furring and framing at exterior masonry and concrete walls.
 - .3 Wood sleepers supporting wood subflooring over concrete slabs in contact with ground or fill.

3.3 MATERIAL USAGE

- .1 Roof sheathing:
 - .1 Plywood, DFP or CSP sheathing grade or PP standard sheathing exterior grade, 19 mm & 13mm thick.
- .2 Underlay:
 - .1 PP, square edge 6 mm thick.

3.4 INSTALLATION

- .1 Install members true to line, levels and elevations, square and plumb.
- .2 Construct continuous members from pieces of longest practical length.
- .3 Install spanning members with "crown-edge" up.
- .4 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.
- .5 Install roof sheathing in accordance with requirements of NBC.
- .6 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding, electrical equipment mounting boards, and other work as required.
- .7 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

- .8 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .9 Install sleepers as indicated.
- .10 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.
- .11 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .12 Countersink bolts where necessary to provide clearance for other work.
- .13 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by rough carpentry installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Read and be governed by conditions of the contract and sections of Division 1.

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM D41-05, Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 - .2 ASTM D312-00(2006), Standard Specification for Asphalt Used in Roofing.
 - .3 ASTM D2178-04, Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
 - .4 ASTM D6162-00a (2008), Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fibre Reinforcements.
 - .5 ASTM D6163-00(2008), Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fibre Reinforcements.
 - .6 ASTM D6164M-11, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements.
 - .7 ASTM D6222M-11 Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcement.
 - .8 ASTM D6223-02(2009), Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcement.
 - .9 ASTM D6509M-09, Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcement.
 - .10 ASTM C665-11, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 37-GP-9Ma-83, Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
 - .2 CGSB 37-GP-56M-80b(A1985), Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
 - .3 CAN/CGSB-51.33-M89, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.
- .3 Canadian Roofing Contractors Association (CRCA)
 - .1 CRCA Roofing Specifications Manual-2011.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA A123.21-10, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems
 - .2 CSA-A123.3-05 (R2010), Asphalt Saturated Organic Roofing Felt.
 - .3 CSA-A123.4-04 (R2013), Asphalt for Constructing Built-Up Roof Coverings and Waterproofing Systems.

- .4 CSA O121-08 (R2013), Douglas Fir Plywood.
- .5 CSA O151-04, Canadian Softwood Plywood.
- .5 Factory Mutual (FM Global)
 - .1 FM Approvals - Roofing Products.
- .6 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Underwriters Laboratories' of Canada (ULC)
 - .1 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .2 CAN/ULC-S702-09-AM1, Standard for Mineral Fibre Thermal Insulation for Buildings.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Convene pre-installation meeting two weeks prior to beginning waterproofing Work, with roofing contractor's representative and NCC Representative to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 45 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Provide two copies of most recent technical roofing components data sheets describing materials' physical properties and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29. - Health and Safety Requirements and indicate VOC content for:
 - .1 Primers.
 - .2 Asphalt.
 - .3 Sealers.
- .3 Manufacturer's Certificate: certify that products meet or exceed specified requirements.
- .4 Test and Evaluation Reports: submit laboratory test reports certifying compliance of membrane with specification requirements.
- .5 Manufacturer's Installation Instructions: indicate special precautions required for seaming the membrane.
- .6 Reports: indicate procedures followed, ambient temperatures and wind velocity during application.

1.5 QUALITY CONTROL

- .1 Installer qualifications: company or person specializing in application of modified bituminous roofing systems with 5 years experience approved by manufacturer.

1.6 FIRE PROTECTION

- .1 Fire Extinguishers:
 - .1 Maintain one cartridge operated type or stored pressure rechargeable type with hose and shut-off nozzle,
 - .2 ULC labelled for A, B and C class protection.
 - .3 Size 14 kg on roof per torch applicator, within 6 m of torch applicator.
- .2 Maintain fire watch for 1 hour after each day's roofing operations cease.
- .3 Contractor shall be extremely cautious during torching applications, in particular in the vicinity of existing wood or decking.

1.7 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Storage and Handling Requirements:
 - .1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
 - .2 Provide and maintain dry, off-ground weatherproof storage.
 - .3 Store rolls of felt and membrane in upright position. Store membrane rolls with salvage edge up.
 - .4 Remove only in quantities required for same day use.
 - .5 Place plywood runways over completed Work to enable movement of material and other traffic.
 - .6 Store sealants at +5 degrees C minimum.
 - .7 Store insulation protected from daylight and weather, and deleterious materials.

1.8 FIELD CONDITIONS

- .1 Ambient Conditions
 - .1 Do not install roofing when temperature remains below -18 degrees C for torch application, or to manufacturers' recommendations for mop application.
 - .2 Minimum temperature for solvent-based adhesive is -5 degrees C.
- .2 Install roofing on dry deck, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roofing system.

1.9 WARRANTY

- .1 For Work of this Section 07 52 00 - Modified Bituminous Membrane Roofing, 12 months warranty period is extended to 24 months.

Part 2 Products

2.1 PERFORMANCE CRITERIA

- .1 Compatibility between components of roofing system is essential. Provide written declaration to NCC Representative stating that materials and components, as assembled in system, meet this requirement.
- .2 Roofing System: to CSA A123.21 for wind uplift resistance.
- .3 All materials must meet requirements of Underwriters Laboratories classified Building Material Index and Fire Resistance Index, ULC 360R 13.

2.2 MATERIALS

- .1 Procure all roofing materials from one manufacturer certified by him as compatible with each other.

2.3 DECK PRIMER

- .1 Asphalt primer: to CGSB 37-GP-9Ma.

2.4 VAPOUR RETARDER

- .1 Self-adhesive vapour retarder: 0.8mm thick SBS-modified bitumen sheet 1.14 meters wide, top surface covered with a high-density polyethylene grid between two layers of polyethylene film.
 - .1 Standard of acceptance Soprapap'r by Soprema or equivalent..

2.5 MEMBRANE

- .1 Base sheet: to CGSB 37-GP-56M.
 - .1 Styrene-Butadiene-Styrene (SBS) elastomeric polymer prefabricated sheet, polyester reinforcement, having nominal weight of 180 g/m².
 - .2 Type 2, fully adhered.
 - .3 Class C - plain surfaced.
 - .4 Grade 2 - heavy duty service.
 - .5 Top and bottom surfaces:
 - .1 Polyethylene / polyethylene.
- .2 Cap sheet membrane: to CGSB 37-GP-56M.
 - .1 Styrene-Butadiene-Styrene(SBS) elastomeric polymer, prefabricated sheet, polyester reinforcement, having nominal weight of 250 g/m².
 - .2 Type 1, fully adhered.
 - .3 Class A-granule surfaced.
 - .1 Colour for granular surface: grey.
 - .4 Grade 2 - heavy duty service.
 - .5 Bottom surface polyethylene.

2.6 ADHESIVE

- .1 Adhesive for securing overlay board and insulation: asphalt extended vulcanized adhesive, two component unit, consisting of two liquids mixed on site to produce pourable adhesive.
- .2 Synthetic rubber based adhesive: fire resistive, fluid, rapid setting, for membranes on vertical surfaces and parapets.
- .3 Non-hygroscopic adhesive: water and fire resistive, fluid, rapid setting. Use as required for cold application of membrane.

2.7 OVERLAY BOARD

- .1 Overlay Board: 6 mm thick asphalt based recovery board with non-woven glass facers, as recommended by the membrane manufacturer.
 - .1 Install over insulation to provide torch safe surface.

2.8 BITUMEN

- .1 Asphalt: to CAN/CSA A123.4, Type 2.

2.9 SEALERS

- .1 Plastic cement: asphalt.
- .2 Sealing compound: rubber asphalt type.
- .3 Sealants: to CAN/CGSB-19.21

2.10 INSULATION

- .1 Batt thermal insulation, chemically inert, non-combustible mineral fibre (stone wool) type: to CAN/ULC S702.
 - .1 Type: 1.
 - .2 Thickness: as indicated.
 - .3 Size: to suit application.
 - .4 Flame spread =0 smoke developed =0 to CAN/ULC S102.
 - .5 Based on ComfortBatt Thermal Home Insulation by Roxul Inc and/or approved equal.

Part 3 Execution

3.1 QUALITY OF WORK

- .1 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and CRCA Roofing Specification Manual, particularly for fire safety precautions.
- .2 Do priming in accordance with manufacturers written recommendations.
- .3 The interface of the walls and roof assemblies will be fitted with durable rigid material sheet metal providing connection point for continuity of air barrier.

- .4 Assembly, component and material connections will be made in consideration of appropriate design loads.

3.2 EXAMINATION OF ROOF DECKS

- .1 Verification of Conditions:
 - .1 Inspect with NCC Representative deck conditions including parapets, construction joints, roof drains, plumbing vents and ventilation outlets to determine readiness to proceed.
- .2 Evaluation and Assessment:
 - .1 Prior to beginning of work ensure:
 - .1 Decks are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris. Do not use calcium or salt for ice or snow removal.
 - .2 Curbs have been built.
 - .3 Plywood and lumber nailer plates have been installed to deck, walls and parapets as indicated.
- .3 Do not install roofing materials during rain or snowfall.

3.3 EQUIPMENT

- .1 Maintain all equipment and tools in good working order.
- .2 Use torch types recommended by the manufacturer of the elastomeric asphalt membranes.
- .3 Maintain functioning fire fighting equipment on roof during torching of membrane operation within 2 m of torching workplace.
- .4 Maintain functioning fire fighting and lighting equipment with an operator on guard inside the roof space during the torching operation on the outside and two hours afterwards.

3.4 PROTECTION OF IN-PLACE CONDITIONS

- .1 Cover walls, walks, sloped roofs and adjacent work where materials hoisted or used.
- .2 Use warning signs and barriers. Maintain in good order until completion of Work.
- .3 Clean off drips and smears of bituminous material immediately.
- .4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.
- .5 Protect roof from traffic and damage. Comply with precautions deemed necessary by NCC Representative.
- .6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.
- .7 Metal connectors and decking will be treated with rust proofing or galvanization.

3.5 VAPOUR RETARDER (CONCRETE/GYPSUM BOARD/PLYWOOD DECK)

- .1 Apply self-adhesive modified bituminous vapour retarder sheet to primed substrate in accordance with manufacturer's instructions.

3.6 (EXPOSED) CONVENTIONAL MEMBRANE ROOFING (CMR) APPLICATION

- .1 Insulation: fully adhered, adhesive application:
 - .1 Adhere insulation to laminated vapour barrier using solvent-based adhesive.
 - .2 Place boards in parallel rows with ends staggered, and in firm contact with one another.
 - .3 Cut end pieces to suit.
 - .4 Apply adhesive in continuous ribbons at 300 mm on centre.
 - .5 Separate the membrane and insulation with a drainage layer or slipsheet.
- .2 Overlay Board: adhesive application:
 - .1 Adhere overlay board to insulation with vulcanized adhesive at the rate of one litre per m².
 - .2 Place boards in parallel rows with end joints staggered. Cap joints approximately 25 mm.
 - .3 Cut ends to suit and apply adhesive in continuous ribbons at 300 mm on centre.
- .3 Base sheet application:
 - .1 Starting at low point of roof, perpendicular to slope, unroll base sheet, align and reroll from both ends.
 - .2 Unroll and embed base sheet in uniform coating of asphalt applied at rate of 1.2 kg/m², at 230 degrees C.
 - .3 Unroll and torch base sheet onto substrate taking care not to burn membrane or its reinforcement or substrate.
 - .4 Lap sheets 75 mm minimum for side and 150 mm minimum for end laps.
 - .5 Application to be free of blisters, wrinkles and fishmouths.
- .4 Cap sheet application:
 - .1 Starting at low point on roof, perpendicular to slope, unroll cap sheet, align and reroll from both ends.
 - .2 Unroll and embed cap sheet in uniform coating of asphalt applied at rate of 1.2 kg/m², EVT at point of contact.
 - .3 Unroll and torch cap sheet onto base sheet taking care not to burn membrane or its reinforcement.
 - .4 Lap sheets 75 mm minimum for side laps and 150 mm minimum for end laps. Offset joints in cap sheet 300 mm minimum from those in base sheet.
 - .5 Application to be free of blisters, fishmouths and wrinkles.
 - .6 Do membrane application in accordance with manufacturer's recommendations.
- .5 Flashings:
 - .1 Complete installation of flashing base sheet stripping prior to installing membrane cap sheet.
 - .2 Torch base and cap sheet onto substrate in 1 metre wide strips.
 - .3 Lap flashing base sheet to membrane base sheet minimum 150 mm and seal by mopping or torch welding.

- .4 Lap flashing cap sheet to membrane cap sheet 250 mm minimum and torch weld.
- .5 Provide 75 mm minimum side lap and seal.
- .6 Properly secure flashings to their support, without sags, blisters, fishmouths or wrinkles.
- .6 Roof penetrations:
 - .1 Install roof drain pans, vent stack covers and other roof penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details.

3.7 FIELD QUALITY CONTROL

- .1 Inspections:
 - .1 Inspection and testing of roofing application will be carried out by testing laboratory designated by NCC Representative.

3.8 CLEANING

- .1 Remove bituminous markings from finished surfaces.
- .2 In areas where finished surfaces are soiled caused by work of this section, consult manufacturer of surfaces for cleaning advice and complying with their documented instructions.
- .3 Repair or replace defaced or disfigured finishes caused by work of this section.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Read and be governed by conditions of the contract and sections of Division 1

1.2 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 ULC-S115-05 Fire Tests of Fire stop Systems.
- .3 National Building Code of Canada 2010.

1.3 DEFINITIONS

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted; (ref: NBC Part 3.1.9.1.1 and 9.10.9.6.1): penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
 - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 45 00 – Quality Control.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit fire resistance rating test listings for firestopping and smoke seal systems.
 - .3 Manufacturer's engineering judgement identification number and shop drawing details when no ULC or cUL or Warnock Hersey system is available for an application. Engineered judgement must include both *project* name and *Subcontractor's* name who will install firestop system as described in shop drawing.

- .4 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.
- .3 Shop Drawings:
 - .1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings and method of installation.
 - .2 Construction details should accurately reflect actual job conditions.
- .4 Quality assurance submittals: submit following in accordance with Section 01 45 00 - Quality Control.
 - .1 Test reports: in accordance with CAN-ULC-S101 for fire endurance and CAN-ULC-S102 for surface burning characteristics.
 - .1 Submit certified test reports from approved independent testing laboratories, indicating compliance of applied fire stopping with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence and cleaning procedures.

1.5 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Installer: person competent in fire stopping installations trained and recognized by fire stopping manufacturer.
- .2 Pre-Installation:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .3 Single source responsibility for firestopping and smoke seal materials:
 - .1 Obtain firestopping and smoke seal materials from single manufacturer for each different product required.
 - .2 Manufacturer shall instruct applicator in procedures for each material.
- .4 Regulatory Requirements:
 - .1 Firestop system installation must meet requirements of ULC S115-05 and ASTM E1966-07 tested assemblies that achieve a fire rating equal to that of construction being penetrated.
 - .2 Proposed firestopping and smoke seal materials and methods shall conform to applicable governing codes having local jurisdiction.

1.6 SYSTEM DESCRIPTION

- .1 Provide firestop and smoke seal systems consisting of a material, or combination of materials installed to retain the integrity of fire-rated construction by effectively impeding the spread of flame, smoke, and/or hot gases through penetrations, blank openings or gaps, membrane penetrations, construction joints, or at perimeter fire containment in or adjacent to fire-rated barriers.
- .2 Provide also smoke sealants applied over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.
- .3 Provide fire-resistance rating equivalent to the rating of the adjacent floor, wall or other fire separation assembly.
- .4 Provide firestopping and smoke sealant system assemblies as practical and as required to coordinate with the schedule and sequencing of the Work.
- .5 Confirm locations of exposed/non-exposed firestopping/smoke seal surfaces with Departmental Representative prior to application.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
 - .3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.
- .2 Storage and Protection:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

1.8 PROJECT CONDITIONS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - .2 When joint substrates are wet.

1.9 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.

- .2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of firestop sealants including special conditions governing use.

Part 2 Products

2.1 ACCEPTABLE MANUFACTURERS / INSTALLATION SPECIALISTS

- .1 General: Manufacturers of firestopping and smoke seal system Products and installation specialists for the work of this section are limited to applicable assemblies as required for the Work and having ULC or cUL or Warnock Hersey labelled packaging.

2.2 MATERIALS

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
 - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended and conforming to specified special requirements described in PART 3.
 - .2 Fire stop system rating: 1 Hour, unless noted otherwise.
- .2 Service penetration assemblies: systems tested to CAN-ULC-S115.
- .3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Fire stopping and smoke seals at openings around fire-resistance rated assemblies for combustible pipes: firestop collar purpose designed to suit application.
- .8 For combustible pipe penetrations through a fire separation required to have a fire resistance rating, provide firestop system with a "F" Rating equal to fire resistance rating of the construction being penetrated.
- .9 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems).
- .10 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .11 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .12 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.

- .13 Sealants for vertical joints: non-sagging.

Part 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 datasheets.

3.2 PREPARATION

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
 - .1 Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

3.3 INSTALLATION

- .1 Install fire stopping and smoke seal material and components in accordance with manufacturer's certified tested system listing.
- .2 Coordinate with other sections to assure that pipes, conduit, cable and other items that penetrate fire rated construction, have been permanently installed prior to installation of firestop assemblies.
- .3 Schedule the Work to assure that penetrations and other construction that conceals penetrations are not erected prior to the installation of firestop and smoke seals.
- .4 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .5 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .6 Tool or trowel exposed surfaces to neat finish.
- .7 Remove excess compound promptly as work progresses and upon completion.

3.4 SEQUENCES OF OPERATION

- .1 Proceed with installation only when submittals have been reviewed by Departmental Representative.

- .2 Mechanical pipe insulation:
 - .1 Ensure pipe insulation installation precedes fire stopping.

3.5 FIELD QUALITY CONTROL

- .1 Inspections: notify Departmental Representative when ready for inspection and prior to concealing or enclosing fire stopping materials and service penetration assemblies.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

3.7 SCHEDULE

- .1 Fire stop and smoke seal at:
 - .1 Penetrations through floor slabs, elevator shaft and walls that enclose vertical service shafts.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials, preparation and application for caulking and sealants.
- .2 Text to complete other various Sections containing sealant or caulking specifications.

1.2 RELATED SECTIONS

- .1 Read and be governed by conditions of the contract and sections of Division 1.

1.3 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CGSB 19-GP-5M-1984, Sealing Compound, One Component, Acrylic Base, Solvent Curing (Issue of 1976 reaffirmed, incorporating Amendment No. 1).
 - .2 CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
 - .3 CGSB 19-GP-14M-1984, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing (Reaffirmation of April 1976).
 - .4 CAN/CGSB-19.17-M90, One-Component Acrylic Emulsion Base Sealing Compound.
 - .5 CAN/CGSB-19.24-M90, Multi-component, Chemical Curing Sealing Compound.
- .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.4 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Manufacturer's product data to describe.
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- .3 Submit samples in accordance with Section 01 33 00 – Submittal Procedures
- .4 Submit duplicate samples of each type of material and colour.
- .5 Cured samples of exposed sealants for each color where required to match adjacent material.
- .6 Submit manufacturer's instructions in accordance with Section 01 33 00 - Submittal Procedures.

- .1 Instructions to include installation instructions for each product used.

1.5 PROJECT CONDITIONS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4 degrees C.
 - .2 When joint substrates are wet.
 - .2 Joint-Width Conditions:
 - .1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
 - .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.6 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.
- .2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

Part 2 Products

2.1 SEALANT MATERIALS

- .1 When low toxicity caulks are not possible, confine usage to areas which offgas to exterior, are contained behind air barriers, or are applied several months before occupancy to maximize offgas time.
- .2 Where sealants are qualified with primers use only these primers.

2.2 SEALANT MATERIAL DESIGNATIONS

- .1 Urethanes One Part. (Type 1).
 - .1 Non-Sag to CAN/CGSB-19.13, Type 2, MCG-2-25, colour to be selected from manufacturer's standard range.
- .2 Acrylic Latex One Part. (Type 2).
 - .1 To CAN/CGSB-19.17.

2.3 SEALANT SELECTION

- .1 Perimeters of exterior openings where frames meet exterior facade of building (i.e. concrete, block, cementitious stucco, masonry): Sealant type: 1.
- .2 Perimeters of interior frames, as detailed and itemized: Sealant type: 2.
- .3 Joints at tops of non-load bearing masonry walls at the underside of poured concrete: Sealant type: 1.

2.4 JOINT CLEANER

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.
- .2 Primer: as recommended by manufacturer.

Part 3 Execution

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
- .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter which may impair Work.
- .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.
- .4 Ensure joint surfaces are dry and frost free.
- .5 Prepare surfaces in accordance with manufacturer's directions.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

- .1 Apply bond breaker tape where required to manufacturer's instructions.
- .2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

- .1 Mix materials in strict accordance with sealant manufacturer's instructions.

3.6 APPLICATION

- .1 Sealant.
 - .1 Apply sealant in accordance with manufacturer's written instructions.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.
 - .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .8 Remove excess compound promptly as work progresses and upon completion.
- .2 Curing.
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.
- .3 Cleanup.
 - .1 Clean adjacent surfaces immediately and leave Work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.
 - .3 Remove masking tape after initial set of sealant.

END OF SECTION

Part 1 - General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit catalogue details for each type of door illustrating profiles, dimensions and methods of assembly.

Part 2 - Products

2.1 ACCESS DOORS

- .1 Sizes: as follows unless indicated:
 - .1 For body entry: 600 x 600 mm minimum.
 - .2 For hand entry: 300 x 300 mm minimum.
- .2 Construction: rounded safety corners, concealed hinges, screwdriver latch, anchor straps, able to open 180 degrees.
- .3 Heavy duty type where indicated to be equipped with safety catch for ceiling installation and upgraded ball bearing latch bolt and ring pull operator. Size 900 x 600 with continuous hinge on long side and up turned sides on door.
- .4 Materials:
 - .1 Tiled or marble surfaces: stainless steel with brushed satin.
 - .2 Other areas: prime coated steel.

2.2 EXCLUSIONS

- .1 Lay-in tile ceilings: use unobtrusive identification locators.

Part 3 - Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for access door installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of NCC Representative.
 - .2 Inform NCC Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NCC Representative.

3.2 INSTALLATION

- .1 Installation: locate access doors within view of equipment and ensure equipment is accessible for operating, inspecting, adjusting, servicing without using special tools.
 - .1 Install gypsum board surfaces: in accordance with Section 09 21 16 - Gypsum Board Assemblies.

3.3 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.4 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by access door installation.

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Read and be governed by conditions of the contract and sections of Division 1.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C475/C475M-02(2007), Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .2 ASTM C557-03(2009)e1, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - .3 ASTM C840-11, Standard Specification for Application and Finishing of Gypsum Board.
 - .4 ASTM C954-11, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
 - .5 ASTM C1002-07, Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
 - .6 ASTM C1047-10a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .7 ASTM C1178/C1178M-11, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Board.
 - .8 ASTM C1396/C1396M-11, Standard Specification for Gypsum Wallboard.
- .2 Association of the Wall and Ceilings Industries International (AWCI)
 - .1 AWCI Levels of Gypsum Board Finish-97.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
 - .2 CAN/CGSB-71.25-M88, Adhesive, for Bonding Drywall to Wood Framing and Metal Studs.
- .4 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .5 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
 - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102.2-10, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store gypsum board assemblies materials level off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect gypsum board assemblies from nicks, scratches, and blemishes.
 - .3 Protect from weather, elements and damage from construction operations.
 - .4 Handle gypsum boards to prevent damage to edges, ends or surfaces.
 - .5 Replace defective or damaged materials with new.

1.4 AMBIENT CONDITIONS

- .1 Maintain temperature 10 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimum after completion of joint treatment.
- .2 Apply board and joint treatment to dry, frost free surfaces.
- .3 Ventilation: ventilate building spaces as required to remove excess moisture that would prevent drying of joint treatment material immediately after its application.

Part 2 Products

2.1 MATERIALS

- .1 Performance / Design Criteria:
 - .1 Partition assembly to be non-combustible construction fire resistance rated at locations indicated: ULC-446 and WHI-5651-0306.1.
- .2 Gypsum board: to ASTM C1396/C1396M regular, 12.7 mm thick, firecode 16mm thick and 25mm thick firecode 7, 1200 mm wide x maximum practical length, ends square cut, edges bevelled.
- .3 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .4 Resilient clips drywall furring : 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.
- .5 Steel drill screws: to ASTM C1002.
- .6 Laminating compound: as recommended by manufacturer, asbestos-free.

- .7 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, zinc-coated by electrolytic process 0.5 mm base thickness, perforated flanges, one piece length per location.
- .8 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
 - .1 VOC limit 250 g/L maximum to SCAQMD Rule 1168.
 - .2 Acoustic sealant: in accordance with Section 07 92 00 - Joint Sealants.
- .9 Polyethylene: to CAN/CGSB-51.34, Type 2.
- .10 Insulating strip: rubberized, moisture resistant, 3 mm thick closed cell neoprene strip, 12 mm wide, with self sticking permanent adhesive on one face, lengths as required.
- .11 Joint compound: to ASTM C475, asbestos-free.

2.2 FINISHES

- .1 Primer: VOC limit 200 g/L maximum to GS-11.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for gypsum board assemblies installation in accordance with manufacturer's written instructions.
 - .1 Inform NCC Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 ERECTION

- .1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.
- .2 Do application of gypsum sheathing to ASTM C1280.
- .3 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.
- .4 Install work level to tolerance of 1:1200.
- .5 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .6 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- .7 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- .8 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .9 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

- .10 Erect drywall resilient furring transversely across studs between the layers of gypsum board, spaced maximum 600 mm on centre and not more than 150 mm from ceiling/wall juncture. Secure to each support with 25 mm drywall screw.
- .11 Install 150 mm continuous strip of 12.7 mm gypsum board along base of partitions where resilient furring installed.

3.3 APPLICATION

- .1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.
- .2 Apply single or double layer gypsum board to wood or metal furring or framing as indicated using screw fasteners for first layer, laminating adhesive for second layer. Maximum spacing of screws 300 mm on centre.
- .3 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .4 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .5 Install gypsum board with face side out.
- .6 Do not install damaged or damp boards.
- .7 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.
- .2 Install casing beads around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Splice corners and intersections together and secure to each member with 3 screws.
- .6 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .7 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .8 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:

- .1 Levels of finish:
 - .1 Level 2 – locations to receive tile finish: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable.
 - .2 Level 4 – all other areas: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.
- .9 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .10 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .11 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .12 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .13 Mix joint compound slightly thinner than for joint taping.
- .14 Apply thin coat to entire surface using trowel or drywall broad knife to fill surface texture differences, variations or tool marks.
- .15 Allow skim coat to dry completely.
- .16 Remove ridges by light sanding or wiping with damp cloth.

3.5 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by gypsum board assemblies installation.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM F1913-04 (2010), Standard Specification for Sheet Vinyl Floor Covering without Backing.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide product data in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Provide samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit duplicate 300 x 300 mm sample pieces of sheet material, 300 mm long base, base backer, edge strips.
- .4 Closeout Submittals:
 - .1 Provide maintenance data for resilient flooring for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

1.5 AMBIENT CONDITIONS

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20 degrees for 48 hours before, during and 48 hours after installation.

1.6 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide extra materials of resilient sheet flooring and adhesives in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide 2 m² of each colour, pattern and type flooring material required for project for maintenance use.
 - .3 Extra materials one piece and from same production run as installed materials.
 - .4 Identify each roll of sheet flooring and each container of adhesive.
 - .5 Deliver to Departmental Representative, upon completion of the work of this section.
 - .6 Store where directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Sheet vinyl without backing : to ASTM F1913-04 (2010), commercial.
 - .1 PVC binder content 90%
 - .2 Pattern: smooth.
 - .3 Colour: selected by NCC Representative.
 - .4 Thickness: 2 mm.
- .2 Integral Vinyl Base: continuous welded joints, complete with remoulded cove support and aluminum top caps.:
 - .1 Type: vinyl.
 - .2 Style: integral cove, welded.
 - .3 Thickness: 2 mm.
 - .4 Height: 101.6 mm.
 - .5 Lengths: cut lengths minimum 2400 mm.
 - .6 Colour: selected by NCC Representative.
- .3 Sub-floor filler and leveller: 2 part latex-type filler requiring no water as recommended by flooring manufacturer for use with their product.
- .4 Metal edge strips:
 - .1 Polished stainless steel with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
- .5 Edging to floor penetrations: stainless steel, type recommended by flooring manufacturer.
- .6 Sealer and wax: type recommended by resilient flooring material manufacturer for material type and location.
- .7 Top Edge of Base: extruded aluminum, type recommended by floor manufacturer.

Part 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 datasheets.

3.2 SITE VERIFICATION OF CONDITIONS

- .1 Ensure concrete floors are clean and dry by using test methods recommended by flooring manufacturer.

3.3 PREPARATION

- .1 Remove or treat old adhesives to prevent residual, old flooring adhesives from bleeding through to new flooring and/or interfering with the bonding of new adhesives.
- .2 Clean floor and apply filler; trowel and float to leave smooth, flat hard surface. Prohibit traffic until filler cured and dry.

- .3 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .4 Prime concrete slab to resilient flooring manufacturer's printed instructions.

3.4 APPLICATION: FLOORING

- .1 Provide high ventilation rate, with maximum outside air, during installation, and for 48 to 72 hours after installation. If possible, vent directly to outside. Do not let contaminated air recirculate through district or whole building air distribution system. Maintain extra ventilation for at least one month following building occupation.
- .2 Apply adhesive uniformly using recommended trowel. Do not spread more adhesive than can be covered by flooring before initial set takes place.
- .3 Lay flooring to produce a minimum number of seams. Border widths minimum 1/3 width of full material.
- .4 Heat weld seams of vinyl sheet flooring in accordance with manufacturer's printed instructions.
- .5 As installation progresses, and after installation roll flooring with 45 kg minimum roller to ensure full adhesion.
- .6 Cut flooring around fixed objects.
- .7 Install feature strips and floor markings where indicated. Fit joints tightly.
- .8 Install flooring in pan type floor access covers. Maintain floor pattern.
- .9 Continue flooring over areas which will be under built-in furniture.
- .10 Continue flooring through areas to receive movable type partitions without interrupting floor pattern.
- .11 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .12 Install metal edge strips at unprotected or exposed edges where flooring terminates.
- .13 Install copper grounding strips per floor manufacturers printed instructions and connect to grounding bar.

3.5 APPLICATION: BASE

- .1 Lay out base to keep number of joints at minimum.
- .2 Clean substrate and prime with one coat of adhesive.
- .3 Apply adhesive to back of base.
- .4 Set base against wall and floor surfaces tightly by using 3 kg hand roller.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions. Use pre-moulded end pieces at flush door frames.

- .7 Use pre-moulded cove base behind all base.
- .8 Heat weld base in accordance with manufacturer's printed instructions.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Remove excess adhesive from floor, base and wall surfaces without damage.
- .3 Clean, seal and wax floor and base surface to flooring manufacturer's printed instructions.

3.7 PROTECTION

- .1 Protect new floors from time of final set of adhesive until final inspection.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Read and be governed by conditions of the contract and sections of Division 1.

1.2 REFERENCES

- .1 Green Seal Environmental Standards (GS)
 - .1 GS-11-2008, 2nd Edition, Paints and Coatings.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
- .4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
 - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Submittal Procedures
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for paint and coating products and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29. - Health and Safety
- .3 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Submit duplicate 200 x 300 mm sample panels of each paint finish with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards.
- .4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Provide and maintain dry, temperature controlled, secure storage.
 - .2 Store painting materials and supplies away from heat generating devices.

- .3 Store materials and equipment in well ventilated area within temperature as recommended by manufacturer.
- .4 Fire Safety Requirements:
 - .1 Supply 1 9 kg Type ABC fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

1.5 SITE CONDITIONS

- .1 Heating, Ventilation and Lighting:
 - .1 Ventilate enclosed spaces.
 - .2 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Apply paint finishes when ambient air and substrate temperatures at location of installation can be satisfactorily maintained during application and drying process, within MPI and paint manufacturer's prescribed limits.
 - .2 Test concrete, masonry and plaster surfaces for alkalinity as required.
 - .3 Apply paint to adequately prepared surfaces, when moisture content is below paint manufacturer's prescribed limits.
- .3 Additional application requirements:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.

Part 2 Products

2.1 MATERIALS

- .1 Supply paint materials for paint systems from single manufacturer.
- .2 Conform to latest MPI requirements for painting work including preparation and priming.
- .3 Materials in accordance with MPI - Architectural Painting Specification Manual "Approved Product" listing.
 - .1 Use MPI listed materials having E2 rating where indoor air quality requirements exist.
 - .2 Primer: VOC limit 100 g/L maximum to GS-11.
 - .3 Paint: VOC limit 100 g/L maximum to GS-11.
- .4 Colours:
 - .1 Submit proposed Colour Schedule to NCC Representative for review.
 - .2 Base colour schedule on selection of 5 base colours and 3 accent colours.
- .5 Mixing and tinting:

- .1 Perform colour tinting operations prior to delivery of paint to site, in accordance with manufacturer's written recommendations. Obtain written approval from NCC Representative for tinting of painting materials.
- .2 Use and add thinner in accordance with paint manufacturer's recommendations.
 - .1 Do not use kerosene or similar organic solvents to thin water-based paints.
- .3 Thin paint for spraying in accordance with paint manufacturer's written recommendations.
- .4 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.
- .6 Gloss/sheen ratings:
 - .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

Gloss Level-Category	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish	Max. 5	Max. 10
Gloss Level 2 - Velvet	Max.10	10 to 35
Gloss Level 3 - Eggshell	10 to 25	10 to 35
Gloss Level 4 - Satin	20 to 35	min. 35
Gloss Level 5 - Semi-Gloss	35 to 70	
Gloss Level 6 - Gloss	70 to 85	
Gloss Level 7 - High Gloss	More than 85	

- .2 Gloss level ratings of painted surfaces as indicated.
- .7 Interior painting:
 - .1 Dressed Lumber: doors, door and window frames, casings, mouldings, etc.:
 - .1 INT 6.3A - Latex G5 finish.
 - .2 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock" type material, etc.
 - .1 INT 9.2A - Latex G3 finish (over latex sealer).

Part 3 Execution

3.1 GENERAL

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.
- .2 Perform preparation and operations for interior painting in accordance with MPI - Architectural Painting Specifications Manual except where specified otherwise.

3.2 EXAMINATION

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to NCC Representative damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using properly calibrated electronic moisture meter, except test concrete floors for moisture using simple "cover patch test". Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

3.3 PREPARATION

- .1 Protection of in-place conditions:
 - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by NCC Representative.
 - .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
 - .3 Protect factory finished products and equipment.
- .2 Surface Preparation:
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
 - .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of NCC Representative
 - .4 Clean and prepare existing exterior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and surface debris by brushing, wiping with dry, clean cloths, or compressed air.
 - .2 Wash surfaces with a biodegradable detergent (and bleach where applicable) and clean warm water using a stiff bristle brush to remove dirt, oil and surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Use trigger operated spray nozzles for water hoses.
 - .5 Allow surfaces to drain completely and to dry thoroughly.
 - .6 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water based paints.
 - .7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or such organic solvents to clean up water-based paints.
 - .5 Clean and prepare surfaces in accordance with MPI - Architectural Painting Specification Manual specific requirements and coating manufacturer's recommendations.

- .6 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .7 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
 - .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
 - .2 Apply wood filler to nail holes and cracks.
 - .3 Tint filler to match stains for stained woodwork.
- .8 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .9 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements.
- .10 Touch up of shop primers with primer as specified.

3.4 EXISTING CONDITIONS

- .1 Prior to commencing work, examine site conditions and existing exterior substrates to be repainted and report in writing to NCC Representative damages, defects, unsatisfactory or unfavourable conditions of surfaces that will adversely affect this work.
- .2 Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter, except test concrete floors for moisture using a simple "cover patch test" and report findings to NCC Representative. Maximum moisture content not to exceed specified limits.
- .3 No repainting work to commence until such adverse conditions and defects have been corrected and surfaces and conditions are acceptable to Painting Subcontractor and Inspection Agency.
- .4 Degree of surface deterioration (DSD) to be assessed using MPI Identifiers and Assessment criteria indicated in the MPI Maintenance Repainting Manual. MPI DSD ratings and descriptions are as follows:

Condition	Description
DSD-0	Sound Surface (includes visual (aesthetic) defects that do not affect film's protective properties).
DSD-1	Slightly Deteriorated Surface (indicating fading; gloss reduction, slight surface contamination, minor pin holes and scratches).
DSD-2	Moderately Deteriorated Surface (small areas of peeling, flaking, slight cracking, and staining).
DSD-3	Severely Deteriorated Surface (heavy peeling, flaking, cracking, checking, scratches, scuffs, abrasion, small holes and gouges).
DSD-4	Substrate Damage (repair or replacement of surface required).

3.5 APPLICATION

- .1 Paint only after prepared surfaces have been accepted by NCC Representative.
- .2 Use method of application approved by NCC Representative.
 - .1 Conform to manufacturer's application recommendations.
- .3 Apply coats of paint in continuous film of uniform thickness.
 - .1 Repaint thin spots or bare areas before next coat of paint is applied.
- .4 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .5 Sand and dust between coats to remove visible defects.
- .6 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .7 Finish inside of cupboards and cabinets as specified for outside surfaces.
- .8 Finish closets and alcoves as specified for adjoining rooms.
- .9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.
- .10 Mechanical/Electrical Equipment:
 - .1 Paint conduits, piping, hangers, ductwork and other mechanical and electrical equipment exposed in finished areas, to match adjacent surfaces, except as indicated.
 - .2 Do not paint over nameplates.
 - .3 Keep sprinkler heads free of paint.
 - .4 Paint both sides and edges of backboards for telephone and electrical equipment before installation.
 - .1 Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
 - .5 Paint canvas and cotton coverings on insulated pipes.
- .11 Standard of Acceptance:
 - .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
 - .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
 - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.
- .12 Apply one primer coat of paint and two finish coats of paint on all new surfaces.

3.6 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

END OF SECTION

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 93 - Testing, Adjusting and Balancing.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE/IESNA 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 National Research Council Canada
 - .1 NRCC NBCC-2010, National Building Code of Canada 2010.

1.3 GENERAL

- .1 This section covers items common to all sections of Divisions 22, 23 & 25.
- .2 Coordinate location & installation of all equipment with all trades to ensure the equipment is serviceable.
- .3 Prime mechanical contractor shall be responsible to ensure that all requirements of Divisions 22, 23 & 25 are met and comply with all other divisions and contract documents.
- .4 The word "provide" shall mean "supply and install".
- .5 Conform to the requirements of Division 00 & Division 01.
- .6 It is a requirement of this Contract that there be a single prime mechanical Sub-contractor who shall retain sub-sub-contractors for all the other mechanical sub-contractors work as defined with contract documentation. There shall not be more than one prime mechanical trade sub-contractor directly retained by the Contractor. Sub-sub mechanical contractor shall include but not limited to, insulation, plumbing, HVAC, controls, refrigerations, service, welding, seismic, acoustic, and specialties, etc. The contractor shall not be the mechanical prime sub-contractor.

1.4 EQUIPMENT

- .1 General:
 - .1 Mechanical equipment that is not regulated by the Green Energy Act, shall carry a permanent label installed by the manufacturers stating the equipment complies with the requirement of ANSI/ASHRAE/IESNA 90.1.
 - .2 The minimum equipment efficiency, standard rating and operating conditions shall be as per ANSI/ASHRAE/IESNA 90.1, superceded by Ontario Building Code (OBC) Supplementary Standard SB -10, unless indicated otherwise on contract documents. The higher of the energy efficiencies of the listed equipment shall prevail.
 - .3 Provide new materials and equipment of proven design, quality and of current models with published ratings for which replacement parts are readily available.
 - .4 Uniformity: Use product of one manufacturer unless otherwise specified, for equipment or material of the same type of classification.
- .2 Installation:
 - .1 Unions, flanges and/or couplings: provide for ease of maintenance and disassembly.
 - .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer, Code or as indicated; whichever is the more stringent.
 - .3 Equipment drains: pipe to floor drains in a manner which is non-obstructing.

- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.
- .5 Unless otherwise specified, follow manufacturer's recommendations for safety, adequate access for inspection, maintenance and repairs.
- .6 Permit equipment maintenance and disassembly with minimum disturbance to connecting piping and duct systems without interference with building structure or other equipment.
- .7 Lubrication: Provide accessible lubricating means for bearings, including permanent lubrication "Lifetime" bearings. Extended grease nipples to be supplied.

1.5 ANCHOR BOLTS AND TEMPLATES

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

1.6 PROTECTION OF OPENINGS

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

1.7 ELECTRICAL

- .1 Electrical work to conform to Division 26 including the following:
 - .1 Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems. Refer to Division 26 for quality of materials and workmanship.
- .2 Any costs associated with deviation of mechanical equipment rating affecting electrical Division 26 shall be carried by this contract.
- .3 All control wiring & conduit associated with Building Automation System & HVAC controls shall be provided by Divisions 22, 23 & 25 including power wiring to all control panels & other field mounted control devices.

1.8 PREPARATION FOR FIRESTOPPING

- .1 Firestopping material and installation within annular space between pipes, ducts, insulation and adjacent fire separation: specified in Section 07 84 00 - Fire Stopping.
- .2 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation.

1.9 PAINTING

- .1 To Section 09 91 23 - Interior Painting.
- .2 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Prime and touch up marred finished paintwork to match original. Use primer or enamel to match original. Do not paint over nameplates.
- .4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.
- .5 Hangers, supports and equipment fabricated from ferrous metals shall be given at least one coat of corrosion resistant primer paint before shipment to job site.
- .6 Touch-up damaged surfaces of all mechanical equipment and materials, to the satisfaction of NCC Representative. Use primer or enamel to match original. Do not paint over nameplates.

1.10 SPARE PARTS

- .1 Furnish spare parts, indicated in various section, and as follows:
 - .1 One casing joint gasket for each size pump.
 - .2 One head gasket set for each heat exchanger.
 - .3 One glass for each gauge glass.
 - .4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

1.11 SPECIAL TOOLS

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers.

1.12 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Where specified elsewhere in Divisions 22, 23 & 25, manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, NCC Representative may record these demonstrations on video tape for future reference.
- .6 Furnish trained instructors to instruct NCC Representative in the operation, maintenance and adjustment of all mechanical equipment; and, instruct personnel on any changes to or modifications of any equipment made under terms of the guarantee.
- .7 The instructions shall take place during regular working hours before systems are accepted and turned over to NCC Representative.
- .8 Ensure that the NCC Representative's operating personnel have received and been given opportunity to review the Operating and Maintenance Manuals prior to commencing instruction. Allow two full days on site for review of these manuals with NCC Representative and for their instruction in operation and maintenance of all mechanical equipment.

1.13 CLOSEOUT SUBMITTALS

- .1 Submit operation and maintenance data for incorporation into manual in accordance with Div. 01 - General Requirements.
- .2 Operation and maintenance manual (O&M) to be approved by, and final copies deposited with, NCC Representative before final inspection.
- .3 For all equipment listed in O&M manuals provide a schedule detailing the supplied component, name, address & phone no. of equipment vendor, parts supplier and warranty agent.
- .4 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.

- .5 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.

- .6 Performance data to include:
 - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified elsewhere.
 - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing.

- .7 Approvals:
 - .1 Submit electronic format (pdf) copy of draft Operation and Maintenance Manual to NCC Representative for approval. Submission of individual data will not be accepted unless so directed by NCC Representative.
 - .2 Make changes as required and re-submit as directed by NCC Representative.
 - .3 Upon acceptance by NCC Representative submit one (1) electronic format (pdf) and three (3) hardcopies of O&M manuals .

- .8 Additional data:
 - .1 Prepare and insert additional data into operation and maintenance manual when the need becomes apparent during demonstrations and instructions specified above.

1.14 ACCEPTABLE PRODUCTS

- .1 Design is based on first manufacturer's name under acceptable products. Subsequent manufacturer's names indicate that those named are acceptable providing they meet specifications and space limitations and are subject to acceptance by Shop Drawing Review.

1.15 SHOP DRAWINGS AND PRODUCT DATA

- .1 Submit single electronic (pdf) copy of shop drawings and product data along with transmittal, in accordance with Section 01 33 00 - Submittal Procedures. Hard copy shop drawings shall not be accepted.

- .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 full equipment performance curves.
 - .4 Manufacturer to certify as to current model production.
 - .5 Certification of compliance to applicable codes.

- .4 The information to be indicated on manufacturers' shop drawings submitted for review shall include the following:
 - .1 General arrangement drawings showing component parts. Where the equipment proposed, or a component part thereof, includes modifications to a manufacturers' standard to meet the requirements of a specification, a complete assembly drawing must be submitted.
 - .2 Overall dimensions, roughing-in dimensions and clearance dimensions of all major components.
 - .3 Mounting details and dimensions.
 - .4 Complete certified performance data for the specified application with particular reference to rate of flow, operating pressure and temperatures, entering and leaving conditions of air or fluid, operating weights, operating limitation, electrical characteristics and BHP requirements.
 - .5 Gauge of fabricated material and finish specification.
 - .6 Vibration isolators and resilient hangers stating locations and weight distribution.
 - .7 Electrical wiring diagrams, control panel boards, motor test data, motor starters and controls for electrically-operated equipment furnished by mechanical trades.
- .5 Review of shop drawings or detail drawings will not relieve the obligation of ensuring that the equipment, materials, or layouts meet the functional requirements of the specifications, and that all necessary mounting space and clearance requirements are met. Thus, the NCC Representative's review is for assistance only.
- .6 No equipment will be accepted on the job site without shop drawings having been reviewed by the NCC Representative.

1.16 CLEANING

- .1 Prior to turnover to client, clean interior and exterior of all new systems. Replace all air & hydronic filters on new & modified systems. Vacuum interior of new and modified ductwork and air handling units.

1.17 AS-BUILT DRAWINGS

- .1 Site records:
 - .1 Mechanical sub-contractor shall mark all changes as work progresses and as changes occur.
 - .2 On a weekly basis, transfer information to record set of documents, revising 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 As-built 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: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
- .3 Submit copies of as-built drawings for inclusion in final TAB report.

1.18 FEES AND PERMITS

- .1 Pay all fees and obtain all permits, taxes relating to the mechanical scope of work.

1.19 WARRANTY

- .1 Unless indicated otherwise provide one (1) year warranty starting at substantial completion for all new systems including materials, equipment & labour.

1.20 LOCATION OF MECHANICAL EQUIPMENT

- .1 Allow for 1500 mm of adjustment for exact location of air handling units, pumps, ducts, piping, etc. at no extra cost or credit.

1.21 CUTTING, PATCHING & CORING

- .1 Provide cutting, patching and coring of all walls, ceiling & concrete slabs and other surfaces as required for mechanical work. Check with NCC Representative prior to core drilling and cutting of structure regarding building requirements and policies. Provide notification, clearance & protection.
- .2 The following procedure shall be followed for cutting & core drilling:
 - .1 Contractor to coordinate and summarize all new cores and openings in building structure. Contractor to investigate on site and locate any existing available hole which may be re-used for new systems.
 - .2 Contractor to prepare a layout sketch showing all existing openings & holes and required new openings & holes, with size and locations to the closest grid line in both directions, and submit for review and approval by the NCC Representative.
 - .3 NCC Representative to provide written report outlining acceptance of the openings, as well as specific requirements for reinforcing at each location.
 - .4 Contractor to proceed with reinforcing tracing as per report and scanning for electrical conduit. Scanning to be completed using ground penetrating Radar (GPR) technology.
 - .5 Contractor shall identify at each location prior to coring and cutting the location, direction and layer of each reinforcing bar and conduit.
 - .6 Any core or opening where reinforcing steel was cut during the cutting & coring process must be retained on site, and the Contractor must inform the engineer with the following information: size of the reinforcing bar, reinforcing layer location (top steel or bottom slab steel) and direction of the bar (east - west or north - south).
- .3 Patch and make good surfaces cut, damaged or disturbed, to NCC Representative's approval. Match existing material, colour, finish and texture or as indicated otherwise.
- .4 Provide dust tight screens or partitions to localize dust generating activities and for protection of finished areas of work, workers and public.

1.22 FINAL INSPECTION

- .1 Do not request final inspection until:
 - .1 Deficiencies are less than 25 items.
 - .2 All systems have been tested and are ready for operation.
 - .3 All air & water balancing has been completed as applicable.
 - .4 The NCC Representative's operating personnel have been instructed in the operation of all systems and equipment.
 - .5 The complete operation and maintenance data books have been delivered to the NCC Representative.
 - .6 All inspection certificates have been furnished including but not limited to seismic certification, City's final plumbing inspection.
 - .7 All record drawings have been completed and approved.
 - .8 All fire extinguishers have been installed.
 - .9 All spare parts and replacement parts have been provided and receipt of same acknowledged.
 - .10 The cleaning up is finished in all respects.

- .11 Upon completion of above, contractor to request in writing for final site review with a minimal 72 hour notification.
- .2 Final installation shall be subject to the approval of the NCC Representative.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.1 REFERENCES

- .1 National Fire Prevention Association (NFPA)
 - .1 NFPA (Fire) 13, Standard for the Installation of Sprinkler Systems, 2013 Edition.
- .2 Underwriter's Laboratories of Canada (ULC).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data in accordance with Section 21 05 01 - Mechanical General Requirements and in accordance with NFPA (Fire) 13, working plans and design requirements.
- .3 Pipe layout shall be the Contractors responsibility and fully coordinated with other trades.

1.3 DRAWING PREPARATION

- .1 Review architectural, structural, mechanical & electrical drawings to determine interferences affecting the distribution layout prior to shop drawing submission.

1.4 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 21 05 01 - Mechanical General Requirements.

1.5 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Provide spare sprinklers and tools as required by NFPA (Fire) 13.

1.6 ACCEPTABLE SPRINKLER CONTRACTORS

- .1 Contractors shall be members of Canadian Automatic Sprinkler Association (CASA).

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

- .3 Storage and Protection:
 - .1 Store materials indoors in dry location.
 - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

Part 2 - Products

2.1 PIPE, FITTINGS AND VALVES

- .1 Pipe:
 - .1 Ferrous: to NFPA (Fire) 13.
 - .2 Ferrous hot dipped galvanized: to NFPA (Fire) 13 in corrosive or damp environments.
- .2 Fittings and joints to NFPA (Fire) 13:
 - .1 Ferrous: screwed, welded, flanged or roll grooved.
 - .2 All exposed piping shall be rigid piping.
- .3 Flexible sprinkler drops:
 - .1 Braided flexible stainless steel sprinkler drops, cULus listed for fire protection service for installation on suspended ceiling grids, wood or metal stud/joist or furring channels.
 - .2 25 mm (1") nominal ID braid hose & fitting made of 304 stainless steel, 1206 kPa (175 psi) maximum working pressure, 178 mm (7") minimum bending radius within length of 750 mm to 1800 mm as per cULus. The maximum amount of allowable bends as per cULus are as follows: 750 mm (36") (5 bends); 1200 mm (48") (8 bends); 1500 mm (60") (10 bends); 1800 mm (72") (12 bends).
 - .3 Inlet nipple 25 mm (1") NPT with straight or 90° reducer for 13 mm (1/2") or 20 mm (3/4") NPT sprinkler.
 - .4 A steel bracket with square bar, adjustable centre bracket & adjustable end brackets suitable for ceiling types. End bracket shall have permanent securement to ceiling system.
 - .5 Acceptable material: Victaulic Model VicFlex AH2; Viking model VKFD28B.
- .4 Valves:
 - .1 ULC listed for fire protection service.
 - .2 Up to NPS 2: bronze, screwed ends, OS&Y rising stem gate or ball valve.
 - .3 NPS 2-1/2 and over: cast iron, flanged or roll grooved ends, OS&Y rising stem gate or butterfly type.
 - .4 Check valves: swing type as above.
 - .5 Ball drip check valve.
- .5 Pipe hangers:
 - .1 ULC listed for fire protection services.
- .6 Sprinkler system shall be rated at 1380 kPa (200 psi).

2.2 SPRINKLERS

- .1 General: to NFPA (Fire) 13 and ULC listed for fire services.
- .2 Provide wire guards in all mechanical rooms, storage areas, electrical rooms, and elevator machine room.
- .3 All sprinklers shall have low zinc content (less than 10%) brass alloy and metal to metal sealing mechanism in the water ways.
- .4 Acceptable materials: Viking, Grinnell, Victaulic & Tyco.

2.3 CONCEALED SPRINKLER

- .1 Fully concealed pendant, quick response for hazard coverage as indicated, 5.6 K factor, enclosed escutcheon, separate two-piece design of mounting cup & coverplate, internal threaded closure, 68°C (155°F) rated, 13 mm (½") adjustment, ULC listed, white enamel chrome finish, glass bulb type and white finish cover.

2.4 UPRIGHT SPRINKLER

- .1 Upright bronze, quick response for hazard coverage as indicated, 5.6 K factor, FM approved, chrome finish, glass bulb type c/w wire guard; 68°C (155°F) rated, 13 mm (½") orifice.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install, inspect and test to acceptance in accordance with Factory Mutual's requirements and NFPA (Fire) 13.
- .2 Testing to be witnessed by Authority having jurisdiction.
- .3 Install and test equipment to manufacturers' standards.

3.2 TESTING

- .1 Pressure test all piping systems as required by NFPA and provide pressure test verification documents.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 00 - Mechanical General Requirements.
- .2 Section 23 05 05 - Installation of Pipework
- .3 Section 23 05 23 - Valves.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
 - .1 ANSI/ASME B16.15-2013, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24-2011, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 ASTM International Inc.
 - .1 ASTM A307-12, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM B88M-05(2011), Standard Specification for Seamless Copper Water Tube (Metric).
- .3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)
 - .1 ANSI/AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 National Research Council (NRC)/Institute for Research in Construction
 - .1 NRCC NPCC-2010, National Plumbing Code of Canada (NPC) - 2010.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 PIPING

- .1 Domestic hot, cold and recirculation systems, within building.
 - .1 Above ground: copper tube, hard drawn, type L: to ASTM B88M.

2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class 150: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class 125: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger: roll grooved to CSA B242.

2.3 JOINTS

- .1 Rubber gaskets, 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5 lead free solder.
- .4 Teflon tape: for threaded joints.

2.4 VALVES

- .1 Refer to Section 23 05 23 - Valves.

Part 3 - Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install in accordance with NPC, Provincial Plumbing Code and local authority having jurisdiction.
- .2 Cut square, ream and clean tubing and tube ends, clean recesses of fittings and assemble without binding.
- .3 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .4 Assemble piping using fittings manufactured to ANSI standards.

- .5 Install DCW piping below and away from DHW and DHWR and other hot piping so as to maintain temperature of cold water as low as possible.
- .6 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

3.3 PRESSURE TESTS

- .1 Conform to requirements of Section 21 05 00 - Mechanical General Requirements.
- .2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.4 FLUSHING AND CLEANING

- .1 Flush system for 8 h.

3.5 PRE-START-UP INSPECTIONS

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.

3.6 DISINFECTION

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction and approval of NCC Representative.

3.7 START-UP

- .1 Timing: start up after:
 - .1 Pressure tests have been completed.
 - .2 Disinfection procedures have been completed.

3.8 OPERATION REQUIREMENTS

- .1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05 - Installation of Pipework.

3.9 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM D2235-04(2011), Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - .2 ASTM D2564-12, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B1800-11, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 South Coast Air Quality Management District (SCAQMD), California State
 - .1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 30 - Health and Safety and Section 01 35 43 - Environmental Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 PIPING AND FITTINGS

- .1 DWV PVC (Polyvinyl Chloride):
 - .1 Application: below grade sanitary, storm & vent piping & fittings.
 - .2 Pipe and Fittings: Drain, waste and vent pipe and fittings shall be certified to CSA B181.2. When combustible pipe and fittings are used in buildings required to be of noncombustible construction, they shall be listed by ULC to the Standard CAN/ULC S102.2 and clearly marked with the certification logo indicating a flame-spread rating not exceeding 25.
 - .3 Acceptable material: IPEX System 15 DWV.
- .2 Fire & smoke resistant coated DWV PVC (Polyvinyl Chloride) piping & fittings:
 - .1 Application: Above grade sanitary, storm & vent piping & fittings where combustible piping is permitted including OBC 3.2.6 High-rise applications and within ceiling plenums.
 - .2 Pipe and Fittings: Drain, waste and vent pipe and fittings shall be certified to CSA B181.2 and when used in noncombustible construction, high-rise buildings and air plenums, they shall be tested and listed in accordance with CAN/ULC S102.2 and clearly marked with the certification logo indicating a flame-spread rating not exceeding 25 and a smoke-developed classification not exceeding 50.
 - .3 Acceptable material: IPEX System XFR 15/50 PVC-DWV.
- .3 Firestopping Devices:
 - .1 All combustible pipe penetrations shall comply with the requirements described in the O.B.C. 3.1.9.4.(1) through (8) and provide a firestop system that has been Tested and Listed to the test Standard CAN/ULC S115 with a pressure differential of 50 Pa. In addition, the manufacturer shall provide a documentation confirming compliance with the Listed system.
- .4 Solvent Welding:
 - .1 Solvent cements shall be CSA certified and meet the requirements of ASTM D2564. One-step cement may be used for sizes from NPS 40 to 150. Two-step cement must be used in conjunction with primer on larger pipe sizes. Proper solvent cementing procedures must be followed at all times.
 - .2 The manufacturer, shall be consulted prior to installation for proper solvent welding procedures and proper solvent cement requirements.
- .5 Expansion/Contraction:
 - .1 Compensation shall be made to accommodate expansion/contraction on the drainage system. It is recommended that there be compensation on every second floor for the vertical piping system. Consult pipe system manufacturer for specific details regarding approved compensation methods.
- .6 Compatibility:
 - .1 To ensure compatibility, performance and material quality, all pipe and fitting drainage system shall be produced by the same manufacturer.
- .7 Quality Control:
 - .1 The manufacturer of the pipe and fitting system shall be contacted prior to the installation to obtain precise installation instructions. Site meetings shall be arranged and include, the Contractor, Manufacturer and Building Inspector.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install in accordance with Canadian Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.
- .2 Bedding and backfilling should be in accordance with City of Ottawa standards and specifications. Install buried pipe on 150 mm (6") bed of compacted clean Granular A bedding compacted to 95% (min.) dry proctor density, shaped to accommodate hubs and fittings, to line and grade as indicated. The material should be placed in maximum 300 mm thick lifts. (If trench bottom is unstable, bring to NCC Representative attention before bedding is laid). Limit vertical deflection and increase pipe support by compacting soil in both directions away from the pipe toward trench walls. Initial backfill to begin at springline of pipe to 300 mm (12") above pipe using compacted clean Granular A bedding compacted to 95% (min.) dry proctor density. Final backfill shall be in accordance with Geotechnical Report and as minimum utilize clean Granular A compacted to 95% dry proctor density in 300 mm thick lifts. Bedding and backfill shall be provided by this division and in accordance with Div. 02 - Site Work. epresentative

3.2 TESTING

- .1 Test in accordance with OBC Part 7 requirements.
- .2 Pressure test buried systems before backfilling.
- .3 Hydraulically test to verify grades and freedom from obstructions.
- .4 Video Testing:
 - .1 Provide video scanning of underground sanitary and storm piping for contractor's review and approval prior to pouring of concrete. Repair deficiencies and re-scan as required. Submit final video to Engineer for record.
 - .2 Flush & video scan sanitary and storm piping for contractor's review and approval prior to building turnover. Repair deficiencies and re-scan as required. Submit final video to Engineer for record.

3.3 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .1 Ensure accessible and that access doors are correctly located.
 - .2 Open, cover with linseed oil and re-seal.
 - .3 Verify cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Ensure that fixtures are properly anchored, connected to system and effectively vented.

3.4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CSA B79-08 (R2013), Acceptable material: Watts, J.R. Smith & Zurn Z-1700. ackflow Preventers and Vacuum Breakers.
- .2 Plumbing and Drainage Institute (PDI)
 - .1 PDI WH201-2010, Water Hammer Arresters Standard.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for fixtures and equipment.
 - .2 Indicate dimensions, construction details and materials for specified items.
- .4 Manufacturers' Field Reports: manufacturers' field reports specified.
- .5 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, include:
 - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
 - .2 Details of operation, servicing and maintenance.
 - .3 Recommended spare parts list.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Divert unused metal materials from landfill to metal recycling facility as approved by NCC Representative.
 - .5 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 - Products

2.1 MATERIALS

- .1 Materials and resources in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

2.2 FLOOR DRAINS

- .1 Floor drains and trench drains: to CSA B79.
- .2 FD1: Medium duty; cast iron body round, adjustable head, 5" (125 mm) dia. nickel bronze strainer, integral seepage pan, trap priming connection and clamping collar.
 - .1 Acceptable material: Watts, Mifab, Zurn ZXN-415-B5P.
- .3 FD2: combination funnel floor drain concrete floor; cast iron body round with integral seepage pan, clamping collar, nickel-bronze adjustable head strainer with integral funnel and trap priming connection.

2.3 CLEANOUTS

- .1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
- .2 Access covers:
 - .1 Wall access: face or wall type, or stainless steel square or round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
 - .2 Floor access: round cast iron body and frame with adjustable secured nickel bronze top, and
 - .1 Plugs: bolted bronze with neoprene gasket.
 - .2 Cover for unfinished concrete floors: nickel bronze round or square, gasket, vandal-proof screws. Acceptable material: Watts, Zurn ZX-1612-BP.
 - .3 Cover for terrazzo finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws. Acceptable material: Watts, Zurn ZX-1400-BP-Z.
 - .4 Cover for tile and linoleum floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws. Acceptable material: Watts, Zurn ZXN-1612-BP-VP.

2.4 TRAP SEAL PRIMERS

- .1 Type 4: Electronic Trap Primer - B.A.S. Type
 - .1 Electronic activated type, all brass construction with "O" ring seals, 12 mm (NPT ½) female inlet & 12 mm (NPT ½) female outlet drip line connection with air gap, viewing holes, and removable filter screen. Trap primer shall have no flow adjustment. Operating range shall be 138 kPa (20 psi) to 861 kPa (125 psi). Unit shall have 120 V or 24 V solenoid valve and calibrated manifold for equal water distribution. One (1) to ten (10) drain taps per unit.
 - .2 Valve to be wired to BAS for remote timed operation.
 - .3 Identify on as-built drawings the location of each trap seal primer.
 - .4 Ensure all trap seal primers are accessible for maintenance purposes and are connected to cold water line. Trap line shall be from top of cold water line and include a service valve. All to be installed in steel cabinet and serviceable from access doors.
 - .5 Acceptable material: Watts, Mifab MI-200, Zurn Z-1020 (1 to 5) for 10 - 2 distribution units will be required.

2.5 WATER HAMMER ARRESSTORS

- .1 Copper construction, bellows or piston type: to PDI-WH201.
- .2 Acceptable material: Watts, J.R. Smith & Zurn Z-1700.

Part 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 data sheet.

3.2 FLOOR DRAINS

- .1 Floor drains to be installed at lowest point in floor and placed to ensure floor finishing is flush/slightly higher than strainer. Contractor to chip concrete around drains, lower assembly, patch concrete and provide floor finish should the installed elevation be unacceptable to Engineer.
- .2 Contractor to provide suitable means of protecting floor drains and cleanouts from damage during construction. Contractor to be responsible for turning over facility to Owner with floor drains and strainers in new condition. Damaged material shall be replaced with new at contractor's expense.

3.3 INSTALLATION

- .1 Install in accordance with National Plumbing Code of Canada, provincial codes, and local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

3.4 CLEANOUTS

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS4.

3.5 WATER HAMMER ARRESTORS

- .1 Install on branch supplies to fixtures or group of fixtures.

3.6 TRAP SEAL PRIMERS

- .1 Install for floor drains and elsewhere, as indicated.
- .2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of NCC Representative.
- .3 Install soft copper tubing to floor drain.

- .4 Identify on as-built drawings the location of each trap seal primer.
- .5 Ensure all trap seal primers are accessible for maintenance purposes. Install access doors if required.

3.7 TESTING AND ADJUSTING

- .1 Floor drains:
 - .1 Verify operation of trap seal primer.
 - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
 - .3 Check operations of flushing features.
 - .4 Check security, accessibility, removeability of strainer.
 - .5 Clean out baskets.
- .2 Cleanouts:
 - .1 Verify covers are gas-tight, secure, yet readily removable.
- .3 Water hammer arrestors:
 - .1 Verify proper installation of correct type of water hammer arrester.

Part 1 - General

1.1 RELATED SECTIONS

- .1 This section shall be read in conjunction with specification Section 21 05 01 - Mechanical General Requirements, all mechanical sections, and all other disciplines related to the project.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA B45 Series-02 (R2013), Plumbing Fixtures (Consists of B45.0-02, B45.1-02, B45.2-02, B45.3-02, B45.4-02, B45.5-02, B45.6-02, B45.7-02, B45.8-02 and B45.9-02), Includes Updates No. 1, No. 2, No. 3, and No. 4 (2007).
 - .2 CSA B125-01, Plumbing Fittings.
 - .3 CSA B651-12, Accessible Design for the Built Environment.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 21 05 01 - Mechanical General Requirements.
- .2 Indicate, for all fixtures and trim:
 - .1 Dimensions, construction details, roughing-in dimensions.
 - .2 Factory-set water consumption per flush at recommended pressure.
 - .3 (For water closets, urinals): minimum pressure required for flushing.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 21 05 01 - Mechanical General Requirements.
- .2 Include:
 - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
 - .2 Details of operation, servicing, maintenance.
 - .3 List of recommended spare parts.

Part 2 - Products

2.1 MANUFACTURED UNITS

- .1 Fixture piping.
 - .1 Hot and cold water supplies to each fixture:
 - .1 Stops supplies shall be all brass with full turn brass seams and replaceable washer attachment shall be IPS inlet x compression OD outlet to fixture. All fixture stop valves shall be screw driver type.
 - .2 Chrome plated in all exposed places.
 - .2 Waste:
 - .1 Cast brass adjustable style P-trap with cleanout on each fixture not having integral trap.
 - .2 Chrome plated in all exposed places.
 - .3 Sink and lavatory heavy gauge P-traps shall be cast brass adjustable style with 17 ga. seamless brass wall bend. Attachment nuts shall be brass, no zinc allowed. P-traps to be removable/union type or to include cleanout.

- .4 Lavatory strainers shall be chrome plated cast brass with 17 ga. seamless brass tailpiece.
 - .5 All barrier-free lavatories and sinks shall have chrome plated offset tail piece in addition to P-trap with cleanout. Insulate P-trap and hot & cold water pipes with pre-formed & finished surface insulation. Armaflex insulation and tape not acceptable.
- .2 Fixtures:
 - .1 Manufacture in accordance with CSA B45.
 - .2 All products, where applicable, shall be marked with manufacturer's name or product #.
 - .3 Trim, fittings: manufacture in accordance with CSA B125.
 - .4 Number, locations: Architectural drawings to govern.
 - .5 Fixtures in any one location to be product of one manufacturer and of same type.
 - .6 Trim in any one location to be product of one manufacturer and of same type unless otherwise indicated.
 - .7 Reference drawing schedule for configuration and type.

2.2 CARRIERS

- .1 Provide for all wall mounted plumbing fixtures.

2.3 ROUGHING-IN OF FIXTURES

- .1 Rough-in for equipment supplied by other to be complete with valved supplies, wastes and vents, capped and associated fitting piping & reducers.

2.4 PLUMBING FIXTURES

- .1 Reference fixture schedule on Drawings.

Part 3 - Execution

3.1 INSTALLATION

- .1 Mounting heights:
 - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
 - .2 Wall-hung fixtures: as indicated on architectural elevations.
 - .3 Physically handicapped: to comply with most stringent of either NBCC, OBC or CAN/CSA B651.

3.2 URINALS

- .1 Urinal waste pipe & fittings shall be DWV PVC equivalent to IPEX System 15 in accordance with specification Section 22 13 18 - Drainage Waste and Vent - Plastic. Extend plastic piping up to combined waste from adjacent lavatory or other plumbing fixtures allowing dilution of waste.

3.3 ADJUSTING

- .1 Conform to water conservation requirements specified in this section.
- .2 Adjustments:
 - .1 Adjust water flow rate to design flow rates and sensors.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
 - .3 Adjust flush valves to suit actual site conditions.
- .3 Checks:
 - .1 Water closets: flushing action.
 - .2 Aerators: operation, cleanliness.
 - .3 Vacuum breakers, backflow preventers: operation under all conditions.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 - Products

2.1 NOT USED

- .1 Not used.

Part 3 - Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer.
 - .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer as indicated without interrupting operation of other system, equipment, components.
-

3.4 DRAINS

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.
 - .1 Discharge to be visible.
- .4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

3.5 AIR VENTS

- .1 Install automatic air vents to at high points in piping systems.
- .2 Install isolating ball valve at each automatic air valve.
- .3 Install drain piping to approved location and terminate where discharge is visible.
- .4 Air units must have minimum connect of 13 mm (½").

3.6 DIELECTRIC COUPLINGS

- .1 General: compatible with system, to suit pressure rating of system.
- .2 Locations: where dissimilar metals are joined.
- .3 NPS 2 and under: isolating unions or bronze valves.
- .4 Over NPS 2: isolating flanges.

3.7 PIPEWORK INSTALLATION

- .1 Screwed fittings jointed with Teflon tape.
- .2 Protect openings against entry of foreign material.
- .3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
- .4 Assemble piping using fittings manufactured to ANSI standards.
- .5 Weldolets, sockolets, saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle. Provide isolation valves at each branch connection.
- .6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .9 Install, except where indicated, to permit separate thermal insulation of each pipe.

- .10 Group piping wherever possible and as indicated.
- .11 Ream pipes, remove scale and other foreign material before assembly.
- .12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .13 Provide for thermal expansion as indicated.
- .14 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball or butterfly valves at branch take-offs for isolating purposes except where specified.
 - .7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
 - .8 Install plug cocks or ball valves for glycol service.
- .15 Check Valves:
 - .1 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: 6 mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
 - .1 Concrete, masonry walls, concrete floors on grade: terminate flush with finished surface.
 - .2 Other floors: terminate 25 mm above finished floor.
 - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
 - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
 - .2 Elsewhere:
 - .1 Provide space for firestopping.
 - .2 Maintain fire rating integrity.
 - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
 - .4 Ensure no contact between copper pipe or tube and sleeve.

3.9 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.
- .2 Construction: one piece type with set screws.
 - .1 Chrome or nickel plated brass or type 302 stainless steel..
- .3 Sizes: outside diameter to cover opening or sleeve.
 - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.
- .3 Provide test results upon completion and return within report on status after completion .

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise NCC Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pework: test to 1½ times operating pressure to a maximum of the piping systems working pressure including devices (i.e. valves, fittings, accessories). Minimum test pressure to be 862 kPa (125 psi).
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of NCC Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. NCC Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by NCC Representative.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by NCC Representative .
- .2 Request written approval by NCC Representative 10days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

3.13 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 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 which are related to control systems specified in Division 22 and 23. 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 90.1-10, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 National Electrical Manufacturers' Association (NEMA)
 - .1 ANSI/NEMA MG 1-2011, Motors and Generators.
- .4 Ontario Regulation
 - .1 ONTARIO OBC-2006, 2006 Ontario Building Code Compendium.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 GENERAL

- .1 Motors to be premium efficiency, in accordance with NEMA 1 premium motor standards and the requirements of ANSI/ASHRAE/IESNA 90.1 unless superceded by Ontario Building Code (OBC) Supplementary Standard SB-10.

2.2 MOTORS

- .1 Provide premium efficiency motors for mechanical equipment to NEMA MG 1 Part 30 & 31 and as specified.

.2 Motors efficiency must exceed the following:

Open Drip-Proof (ODP) Type

Motor Size	Speed (RPM)		
	1200	1800	3600
HP	NEMA Premium Nominal Efficiency		
1 & below	82.5%	85.5%	77.0%
1.5	86.5%	86.5%	84.0%
2	87.5%	86.5%	85.5%
3	88.5%	89.5%	85.5%
5	89.5%	89.5%	86.5%
7.5	91.0%	91.0%	88.5%
10	91.7%	91.7%	89.5%
15	91.7%	93.0%	90.2%
20	92.4%	93.0%	91.0%
25	93.0%	93.6%	91.7%
30	93.6%	94.1%	91.7%
40	94.1%	94.1%	92.4%
50	94.1%	94.5%	93.0%
60	94.5%	95.0%	93.6%
75	94.5%	95.0%	93.6%
100	95.0%	95.4%	93.6%
125	95.0%	95.4%	94.1%
150	95.4%	95.8%	94.1%
200	95.4%	95.8%	95.0%

Totally Enclosed Fan-Cooled (TEFC) Type

Motor Size	Speed (RPM)		
	1200	1800	3600
HP	NEMA Premium Nominal Efficiency		
1 & below	82.5%	85.5%	77.0%
1.5	87.5%	86.5%	84.0%
2	88.5%	86.5%	85.5%
3	89.5%	89.5%	86.5%
5	89.5%	89.5%	88.5%
7.5	91.0%	91.7%	89.5%
10	91.0%	91.7%	90.2%
15	91.7%	92.4%	91.0%
20	91.7%	93.0%	91.7%
25	93.0%	93.6%	91.7%
30	93.0%	93.6%	91.7%
40	94.1%	94.1%	92.4%
50	94.1%	94.5%	93.0%
60	94.5%	95.0%	93.6%
75	94.5%	95.4%	93.6%
100	95.0%	95.4%	94.1%
125	95.0%	95.4%	95.0%
150	95.8%	95.8%	95.0%
200	95.8%	96.2%	95.4%

.3 Motors under 373 W (½ HP): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.

.4 Motors 373 W (½ HP) to 14.92 kW (20 HP): EEMAC Class B/F, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 45°C/60°C over ambient of 30°C, 3 phase, 600 V, unless otherwise specified or indicated.

- .5 Motors 18.65 kW (25 HP) and larger: EEMAC Class B/F, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 45°C/60°C over ambient of 30°C, 3 phase, 600 V, c/w integral thermistor protection, unless otherwise specified or indicated. Thermistors shall be factory installed, copper RTD type, one on each phase, wired to identified terminals in motor terminal box and wired to starter/VFD (wiring, conduit & connections by Div. 26).
- .6 Two speed motors shall be double winding type.
- .7 Motors coupled with VFD shall be premium efficiency, inverter duty type to NEMA MG 1 Part 31 and shall have as a minimum EEMAC Class F insulation. There shall be no restrictions on the cable length between the VFD and the motor. Inverter ready motors shall not be acceptable.

2.3 TEMPORARY MOTORS

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

Part 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 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA).
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 ANSI/NEMA MG 1-2011, Motors and Generators, Part 31.
- .3 Underwriters Laboratories (UL).

1.2 SCOPE

- .1 Provide Variable Frequency Drives (VFD's) for the equipment listed on Drawing Schedules.
- .2 Provide on-site commissioning (start-up) of the Variable Frequency Drives by factory trained service personnel. Adequate time must be allowed to thoroughly and safely start, program, and test run the VFD with the building management system. A separate site visit to be provided for training of operation and maintenance personnel.
- .3 The contractor is responsible for ensuring that the existing equipment is in top operating condition before the commissioning of the VFD's occur. Any additional work required to bring the equipment into top operating condition should be brought to the Engineers attention.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 All bid submittals must include the following:
 - .1 A detailed description of all components in the VFD package, including line and load reactor impedance ratings and or filter design type, VFD current, HP, and voltage rating.
 - .2 A list of any exceptions to this specification.
 - .3 Harmonic specification compliance calculations.
- .3 All approval submittals shall include the following and approvals must be received prior to delivery of any goods:
 - .1 Schematic wiring diagram showing all VFD package component connections and all serial, digital and analog inputs and outputs to be connected to the control system.
 - .2 Mechanical dimensional drawings with mounting details.
- .4 On completion of the installation, the supplier shall provide the following:
 - .1 Full commissioning report documenting all programmable settings, AC input voltage, DC Bus voltage, current draw at maximum speed, amp vs speed curve and a description of ambient conditions.
 - .2 One operators manual for each VFD installed.
 - .3 One 216 mm x 279 mm wiring diagram for each VFD installed.
- .5 Closeout Submittals
 - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 GENERAL DESIGN CHARACTERISTIC

- .1 The VFD shall be of the Pulse Width Modulated (PWM) voltage source type, utilizing fixed diode bridge input rectification and Insulated Gate Bipolar Transistor (IGBT) / Intelligent Power Module (IPM) technology.
- .2 The VFD's digital electronic control board(s) shall be manufactured using Surface Mount Technology (SMT).
- .3 The VFD shall be dual rated for variable torque applications, with the continuous duty output current on the nameplate. The overload rating shall be 110% for 60 seconds. The VFD shall be selected such that the continuous duty current rating shall be equal to or greater than the connected motor full load current rating.
- .4 All VFD's shall be factory CSA/CUL certified.
- .5 All packaged drive systems shall be CSA certified.
- .6 The VFD shall have the capability of operating multiple motors. The minimum VFD continuous current rating shall be the sum of the full load current ratings of the connected motors.
- .7 The VFD shall be capable of operating in an open circuit mode i.e. with the motor(s) disconnected, for start-up and test purposes.
- .8 The VFD shall have a minimum displacement power factor of 0.96 or higher at all output frequencies.
- .9 The VFD and all options (e.g. line and load reactors, filters, bypass, etc.) must be manufacturer wired & warrantied as an assembly in NEMA 1 enclosures. The enclosures may be of a Wall or Floor mount design, depending on the rating, and be supplied with forced ventilation complete with cleanable air filters in enclosures where components produce excessive heat.
- .10 The VFD manufacturer shall have a minimum of five years experience in the Canadian Market.
- .11 Warranty of the VFD System shall be for 24 months from the date of start-up or thirty months from date of delivery, whichever is sooner. The warranty shall include all parts and repair labour. The VFD manufacturer shall have the ability to repair the system within 24 hours of notification.

1.5 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial /Territorial regulations.
- .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 ACCEPTABLE MATERIALS

- .1 Hitachi, ABB, Danfoss, Yaskawa.

2.2 STANDARD VFD DESIGN FEATURE

- .1 Microprocessor Logic: The VFD shall include a 32 bit microprocessor and DSP (Digital Signal Processor). A digital display keypad shall be provided for input of parameter setting and operating commands. The digital display shall indicate output frequency, motor RPM, output current, as well as fault history information.
- .2 Digital Inputs: The VFD shall include a minimum of five (5) digital inputs programmable for function. Each input shall also be programmable to operate as a normally open (n/o) or normally closed (n/c) contact.
- .3 Analog Inputs: The VFD shall accept an analog speed reference input signal of 0-5 V DC, 0-10 V DC, and/or 4-20 ma). If both inputs are active, the 0-10V DC (or 0-5 V DC) or 4-20 mA signals shall be selectable by a digital input.
- .4 Digital Outputs: The VFD shall include two(2) digital outputs each programmable for drive run, frequency arrival (at set speed) or over torque. Each output shall also be programmable to operate as a normally open (n/o) or normally closed (n/c) contact.
- .5 Analog Output: The VFD shall provide an analog pwm output signal (0-10 V DC, @ 1 ma) proportional to the output frequency or output current.
- .6 Alarm Relay Outputs: The VFD shall provide an alarm relay which activates during a fault condition. The relay contacts shall include a set of normally open/normally closed (form c) contacts.
- .7 Auto Restart: The VFD shall have the capability to automatically restart the motor after an interruption in input power.
- .8 Critical Frequency Rejection: The VFD shall provide a minimum of three(3) selectable jump frequency points used to avoid critical resonance of the mechanical system. Frequency bandwidth for each jump frequency shall be programmable from 0 to +/- 9.9 Hz.
- .9 DC Injection Braking: The VFD DC braking control shall be capable of automatic initiation prior to all start commands to stop a "wind-milling" fan motor before issuing a run command. The duration and amplitude of this setting is to be programmable through the operator interface.
- .10 Acceleration/Deceleration Control: The VFD shall provide independent programmable settings for accel/dec l time (0-999 seconds). The VFD shall also include a setting to allow the motor to coast to a stop. Acceleration and deceleration shall be programmable for linear, S-Curve, U-Curve or Reverse-U-Curve output.
- .11 Carrier Frequency: The carrier frequency shall be programmable from 3 kHz up to a maximum of 16 kHz in 0.1 increments.
- .12 Energy Savings:
 - .1 The VFD shall be programmable for variable torque V/F curves to optimize energy consumption.
 - .2 The VFD shall include an Automatic Energy Savings feature to further reduce energy consumption by minimizing the current demand of the motor for a given load, automatically.
- .13 Automatic Voltage Regulation: The VFD shall maintain the rated starting torque independent of the input voltage tolerance of +/-10%.

- .14 Power Loss Ride-through: The VFD shall have a ride-through capability during an intermittent loss of power for up to 15 mSec.
- .15 Min/Max Speed: Minimum and maximum speed settings shall be adjustable from 0 - 100%.
- .16 Fault Log: A fault log will record the total number of faults and display details of the last three faults, including reason for fault, frequency at time of fault, current at time of fault, and DC Bus Voltage at time of fault.
- .17 Pre-set Speeds: Using the digital inputs a minimum of 7 programmable pre-set speeds shall be selectable.
- .18 Safety Interlocks: Terminals to be provide for connection of safety interlocks such as [motor thermistors] Fire-stat and Freeze-stat. These interlocks shall shutdown operation in either the Drive or Bypass operating modes.
- .19 Door Mounted Operator Controls/Indicators: The basic operator controls shall consist of the following:
 - Hand - Off - Auto Selector Switch
 - Potentiometer for setting speed in "Hand"
 - Indicating Lights for:
 - Power On
 - Run
 - Fault
 - Drive Keypad for setting parameters, control and viewing of Speed, Current, and Alarms
 - Bypass

2.3 OUTPUT RATINGS

- .1 The VFD shall operate within the following rated values.
 - .1 Output Frequency Range: 0.1 to 400 Hz.
 - .2 Frequency Accuracy: +/- 0.01% with respect to digital input setting.
 - .3 Overload Rating: VT - 125% for 60 seconds.

2.4 INPUT POWER

- .1 Voltage: 3 phase (3 wire) 600V +/- 10%
- .2 Frequency: 60 Hz +/- 5%

2.5 ENVIRONMENTAL RATINGS

- .1 The VFD shall operate within the following parameters without the need for derating:
 - .1 Temperature: -10 to 40°C.
 - .2 Humidity: 20 - 90% RH non-condensing.
 - .3 Altitude: up to 1,000 meters.
 - .4 Vibration of 0.2 G or less.

2.6 PROTECTIVE FEATURES

- .1 The VFD shall be designed to include the following protective functions and displays for maintainability:
 - .1 All control circuits (5, 12, & 24 V DC) shall be physically and electrically isolated from the power circuit voltages to ensure safety to maintenance personnel.
 - .2 Instantaneous Over Current Protection: The output of the VFD shall automatically be turned off if the operating current exceeds the specified level.
 - .3 Motor Overload Protection: The VFD shall include electronic thermal overload protection for automatic reduction of the overload limit at reduced operating speed. Overload protection shall be provided in

both VFD and bypass operation. The output of the VFD shall be disabled if the motor's thermal rating is exceeded.

- .4 External Trip: The VFD shall have the capability to accept an external trip input and the input shall be programmable for either N/O or N/C operation.
- .5 Phase Loss Protection: Phase loss detection shall be provided to prevent single phasing of the VFD input.
- .6 Unattended Start Protection: The VFD shall include a user selectable function to prevent an automatic restart after an interruption in input power.
- .7 Over Voltage Protection: The output of the VFD shall be automatically cut off if the DC Bus voltage exceeds the specified level due to regenerative energy from the motor.
- .8 Ground Fault Protection: The VFD shall have the capability to sense current imbalance during motor start-up for protection of the power circuit in the event of a ground fault.
- .9 Software Lock The VFD shall include a software function which prevents changes to the user defined settings.
- .10 Power Module Protection: The IPM shall incorporate thermal and short circuit protection circuits.
- .11 CPU or EEPROM Error: VFD shall automatically be turned off in the event of an error in the CPU or EEPROM.
- .12 Option board communication error: VFD will automatically be turned off in the event of an option board error.

2.7 RELIABILITY

- .1 A complete description of the manufacturer's quality assurance and testing program shall be provided.
- .2 Printed Circuit Boards / Pre-assembly: All blank circuit boards shall be checked for appearance, dimensions and continuity as per specification. All electronic components shall be subjected to a visual and functional test. Circuit board components shall be stored at 15-30°C @ 5 % humidity.
- .3 Printed Circuit Board Inspection: All surface-mount devices shall be subjected to microscopic inspection for component alignment and solder joint integrity. All completed circuit boards shall undergo a thermal stress test with temperatures cycled between -5 to 65°C.
- .4 All VFD's of a series shall use one common logic printed circuit board for all units supplied.

2.8 INPUT FILTERING

- .1 All VFD's shall be furnished with the following protective devices as a minimum: All 600V systems require 5% impedance harmonically compensated Line reactors rated to carry 150% total RMS current continuously for the reduction of line harmonics and to limit line voltage transients.

2.9 OUTPUT FILTERING

- .1 All VFD's shall be furnished with LRC Sine wave output filter to match load.

2.10 INTEGRAL BYPASS

- .1 Provide Bypass package in a NEMA 1 enclosure. Bypass shall include three (3) contactors for manual switching from the VFD to line and from Line to VFD. Control Transformer, Class J fuses relay and:
 - .1 Provide an Operator station consisting of:
 - Hand-OFF-Auto Selector Switch
 - VFD-Off-Bypass Selector Switch
 - Auto Bypass Enable Switch
 - Test Mode Switch
 - Manual Speed Potentiometer

- Power On Light
 - External Trip On Light
 - Hand Operation Light
 - Auto Operation Light
 - VFD On Light
 - VFD Run Light
 - VFD Fault Light
 - Frequency Arrival (at set speed) Light
 - Bypass On Light
 - Bypass Fault Light
 - Auto Bypass Enable Light
 - Test Mode Light
- .2 When in Bypass Mode the VFD shall be isolated from the line and motor to enable servicing by qualified personnel. The Drive output contactor and the bypass contactor must be mechanically interlocked to prevent simultaneous closure.
 - .3 Provide dry contacts for Fault, Run Status, and Frequency arrival to the building automation system.
 - .4 Provide a 24 VDC power supply.
 - .5 The Drive output contactor and the bypass contactor must be mechanically interlocked to prevent simultaneous closure.
 - .6 Provide overload protection in the bypass circuit.

2.11 DISCONNECT SWITCH

- .1 Provide fusible Input Disconnect complete with Class J 200 kA interrupt fuses (sized per CEC tables), for all VFD installations. The Fusible disconnect shall be integrally mounted and wired within the enclosure and be provided with a door interlock mechanism to prevent unauthorized entry with the power on. In addition the disconnect must have provision for padlocking in the off position. Service personnel shall be able to open the door when the system is operating.

2.12 DIGITAL KEYPAD

- .1 Provide a multi-line display (minimum 4 lines) (68 characters) digital backlit keypad that employs words and numbers for easy operator interface. Keypad shall be capable of monitoring, programming, and operating the VFD.

2.13 OVERLOAD RELAY

- .1 Provide a separately mounted Class 20 overload relay for each motor. Provide door mounted overload reset buttons.

Part 3 - Execution

3.1 START-UP AND COMMISSIONING SERVICES

- .1 The manufacturer shall provide start-up and commissioning of the variable frequency drive and its optional circuits by a factory certified service technician who is experienced in start-up and repair services. The commissioning personnel shall be the same personnel that will provide the factory service and warranty repairs at the customer site. Sales personnel and other agents who are not factory certified technicians for drive repair shall not be acceptable as commissioning agents. The manufacturer shall have the ability to repair his products within 24 hours of notification of failure.
- .2 Start-up services shall include checking for verification of proper operation and installation of the VFD, its options and its interface wiring to the building automation system. Included in this service shall be as a minimum:
 - .1 Verification of contractor wire terminations and conduit runs to and from the VFD.
 - .2 One hour of customer operator training on the operation and service diagnostics at the time of commissioning.
 - .3 Measurement for verification of proper operation of the following:
 - .1 Motor voltage and frequency. Verification of proper motor operation.
 - .2 Control input for proper building automation system interface and control calibration.
 - .3 Calibration check for the following set-points:
 - .1 minimum speed
 - .2 maximum speed
 - .3 acceleration and deceleration rates.
- .3 Commissioning agent to verify the programming of the VFD and to provide a written copy of the settings to the engineer.
- .4 Commissioning agent to lock out critical frequencies throughout the operating curve of the equipment as identified and required by the engineer. The agent shall record amperages at six (minimum) different frequencies from minimum to maximum speed.

3.2 EXAMINATION

- .1 The contractor is to verify that the job site conditions for installation meet the factory recommended and code required conditions for the VFD installation prior to start-up. These shall include as a minimum:
 - .1 Clearance spacing.
 - .2 Compliance with environmental ratings of the VFD system.
 - .3 Separate conduit installation of the input wiring, the motor wiring, and control wiring. At no time does any of this wiring run in parallel with each other.
 - .4 All power and control wiring is complete.
- .2 The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD system shall not be operated while the unit is covered.
- .3 Power shall not be applied until the manufacturer has started up his equipment.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

Part 2 - Products

2.1 FLEXIBLE CONNECTION

- .1 Application: to suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.
- .3 Inner hose: bronze corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
 - .1 To match system requirements.

2.2 EXPANSION JOINTS, PIPE GUIDES AND PIPE ANCHORS

- .1 Expansion compensator for pipe size NPS 3/4 up to NPS 3, bronze model bellow-two ply, stroke 75 mm compression, 6 mm extension. Rated for 1034 kPa maximum working pressure. All bronze construction for copper pipes; steel construction for steel pipes. Acceptable material: Flexonics, Hyspan, Pathway.
- .2 Expansion joint NPS 4 and NPS 6, controlled flexing expansion joint, Class 150, steel flanged ends, single type, rate for 1034 kPa maximum working pressure, maximum temperature range -28°C to 454°C, axial and lateral movement, 8 corrugations, 304 stainless steel bellows. Acceptable material: Flexonics, Hyspan, Pathway.

Part 3 - Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

- .1 Install expansion joints and flexible connections in accordance with manufacturer's instructions.

3.3 PIPE CLEANING AND START-UP

- .1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2010, Power Piping.
 - .2 ANSI/ASME B31.3-2010, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2010:
 - .1 BPVC 2010 Section I: Power Boilers.
 - .2 BPVC 2010 Section V: Nondestructive Examination.
 - .3 BPVC 2010 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
 - .2 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
 - .3 CSA-W117.2-12, Safety in Welding, Cutting and Allied Processes.
 - .4 CSA W178.1-14, Certification of Welding Inspection Organizations.
 - .5 CSA W178.2-14, Certification of Welding Inspectors.

1.2 QUALIFICATIONS

- .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications to NCC Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.

1.3 INSPECTOR QUALIFICATIONS

- .1 Inspectors qualified to CSA W178.2.

1.4 WELDING PROCEDURES

- .1 Registration of welding procedures in accordance with CSA B51.
- .2 Copy of welding procedures available for inspection.
- .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

Part 2 - Products

2.1 WELDING CONSUMABLES

- .1 Certified to ASME SFA specifications.

2.2 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

Part 3 - Execution

3.1 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to ASME BPVC, Section IX.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with NCC Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with NCC Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during pipe joint fit-up and preparation, and welding of circumferential pipe welds after each pass deposited in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General.
 - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by NCC Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 100% of pipe welds in accordance with "Inspection and Test Plan" by non-destructive visual examination and by the NDE methods below.

- .2 The required NDE will be done on weld joints on all glycol piping welds.
 - .1 NDE will be as follows.
 - .1 Piping Welds: All welds in piping will be visually inspected during pipe joint fit-up, and preparation and welding of circumferential pipe welds. Visual welding inspection shall be performed after each pass deposited. All glycol piping welds will be examined by radiographic test.
 - .2 The acceptance criteria for radiographic particle test and PT is ASME Section V.
- .3 Hydrostatically test all other piping welds to requirements of ANSI/ASME B31.1.
- .4 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .5 Failure of visual examinations:
 - .1 Upon failure of any weld by visual examination, perform additional testing as directed by NCC Representative of a total of up to 20% of all welds, selected at random by the NCC Representative by radiographic particle tests.

3.6 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense as described in ANSI/ASME B31.1 and ASME BPVC.

Part 1 - General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-14.4-M88, Thermometers, Liquid-in-Glass, Self Indicating, Commercial/Industrial Type.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit shop drawings and product data.
- .3 Submit manufacturer's product data for following items:
 - .1 Thermometers.
 - .2 Pressure gauges.
 - .3 Ball valves.
 - .4 Syphons.
 - .5 Wells.

1.3 HEALTH AND SAFETY

- .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

Part 2 - Products

2.1 GENERAL

- .1 Design point to be at mid point of scale or range.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, liquid filled, 125 mm scale length: to CAN/CGSB 14.4 & ASME B40.200.

2.3 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: brass.

2.4 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale, steam mounting.
- .2 Provide ball valve and snubber for pulsating operating (pumps).

Part 3 - Execution

3.1 GENERAL

- .1 Install so they can be easily read from floor or platform. If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

3.2 THERMOMETERS

- .1 Install in wells on piping. Provide heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of heat exchangers.
- .3 Use extensions where thermometers are installed through insulation.

3.3 PRESSURE GAUGES

- .1 Install in following locations:
 - .1 Suction and discharge of pumps.
 - .2 In other locations as indicated.

Part 1 - General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.34-2013, Valves Flanged, Threaded and Welding End
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A193/A193M-14, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - .2 ASTM A194/A194M-14, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - .3 ASTM A216/A216M-14, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
 - .4 ASTM A351/A351M-14, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - .5 ASTM A564/A564M-13, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - .6 ASTM B16/B16M-10, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
 - .7 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS SP-61-2011, Pressure Testing of Valves.
 - .2 MSS SP-68-2013, High Pressure Butterfly Valves with Offset Design.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for valves and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit data for valves specified in this section.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

Part 2 - Products

2.1 GENERAL

- .1 All valves of the same type to be from one manufacturer.
- .2 All valves to have CRN registration numbers.

2.2 BUTTERFLY VALVES - Class 150

- .1 Sizes: NPS 2 and over.
- .2 Style: Lug body for end of line service in either direction.
- .3 Pressure rating: Class 150.
- .4 Bolting: ASME Class 150 steel flanges.
- .5 Operators: Worm gear operator.
- .6 Valves shall be High Performance Butterfly type with offset seat in conformance with MSS SP-68. Valve body shall be Class 150 in conformance with ASME B16.34. Valve seat shall be rated for bubble tight shut-off up to the full body rating (1,965 kPa at 38 degrees C) of the valve with either downstream flange removed.
- .7 Valves shall have internal stop to prevent disc over-travel.
- .8 Valves shall have retained top and bottom low friction bearings.
- .9 Valve shall be equipped with stainless steel nameplate indicating:
 - .1 Valve make
 - .2 Valve model
 - .3 Valve serial number
 - .4 CRN number
 - .5 Bi-directional, end-of-line cold water pressure rating
- .10 Construction:
 - .1 Body: ASTM A216 Gr. WCB Cast steel
 - .2 Disc: ASTM A351 Gr. CF8M
 - .3 Shaft: ASTM A564 type 630 H1150
 - .4 All other materials selected by manufacturer for the specified performance rating.

2.3 CHECK VALVES

- .1 NPS 2½ and over, cast steel:
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Provide Class 150 valve.

2.4 BALL VALVES

- .1 NPS 4 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62 or brass to ASTM B16/B16M C36000.
 - .2 Stem: tamperproof ball drive.
 - .3 Stem packing nut: external to body.
 - .4 Ball and seat: replaceable chrome plated brass solid full port ball and teflon seats.
 - .5 Stem seal: TFE with external packing nut.
 - .6 Operator: removable lever handle.
 - .7 Provide Class 150 valve.

2.5 CIRCUIT BALANCING VALVES (CBV)

- .1 General:
 - .1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.
- .2 Accuracy:
 - .1 Readout to be within plus or minus 2% of actual flow at design flow rate.
- .3 Pressure die-cast dezincification resistant copper alloy construction, Teflon disc, screw-in bonnet.
 - .1 Flow control: At least four 4 full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.
- .4 Insulation:
 - .1 Use prefabricated shipping packaging of 5.4 R polyurethane as insulation.
- .5 Drain connection:
 - .1 NPS 3/4 valved and capped, suitable for hose socket.
 - .2 Incorporated into valve body or provided as separate item.

Part 3 - Execution

3.1 PREPARATION

- .1 Valve and mating flange preparation.
 - .1 Inspect adjacent pipeline, remove rust, scale, welding slag, other foreign material.
 - .2 Ensure that valve seats and pipe flange faces are free of dirt or surface irregularities which may disrupt flange seating and cause external leakage.
 - .3 Install butterfly valves with disc in almost closed position.
 - .4 Inspect valve disc seating surfaces and waterway and eliminate dirt or foreign material.

3.2 INSTALLATION OF VALVES

- .1 Install in accordance with manufacturer's instructions.
- .2 Do not use gaskets between pipe flanges and valves unless instructed otherwise by valve manufacturer.
- .3 Verify suitability of valve for application by inspection of identification tag.
- .4 Mount actuator on to valve prior to installation.
- .5 Handle valve with care so as to prevent damage to disc and seat faces.

- .6 Valves in horizontal pipe lines should be installed with stem in horizontal position to minimize liner and seal wear.
- .7 Ensure that valves are centered between bolts before bolts are tightened and then opened and closed to ensure unobstructed disc movement. If interference occurs due, for example to pipe wall thickness, taper bore adjacent piping to remove interference.

3.3 TESTING, INSPECTION AND CERTIFICATION

- .1 Valve shall be certified in writing by the manufacturer as been tested in conformance to hydrostatic shell and seat tests of ASME B16.34 and MSS SP-61 and shall state that its shutoff rating for cold water service is up to 1,965 kPa for Class 150 with either downstream flange removed.

3.4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Clean installed products in accordance to manufacturer's recommendation.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Hangers and supports for mechanical piping.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2014, Power Piping.
- .2 ASTM International
 - .1 ASTM A563-07a(2014), Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-58-2009, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturer's regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by MSS SP-58, ASME B31.1.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Hangers and supports to support systems under conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP-58.

1.4 SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Submit shop drawings and product data for following items:
 - .1 Hangers.
- .4 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .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 NCC Representative will make available 1 copy of systems supplier's installation instructions.

1.5 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.6 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/ Demolition Waste Management and Disposal.

Part 2 - Products

2.1 GENERAL

- .1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1 and MSS SP-58.

2.2 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized after manufacture.
 - .2 Use electro-plating galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are epoxy coated.
- .2 Upper attachment structural: suspension from lower flange of I-Beam:
 - .1 Cold piping NPS 2-1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, UL listed to MSS-SP-58.
- .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2-1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut UL listed.
- .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate UL listed to MSS SP-58.
- .5 Shop and field-fabricated assemblies:
 - .1 Trapeze hanger assemblies.
 - .2 Steel brackets.
- .6 Hanger rods: threaded rod material to MSS SP-58:
 - .1 Ensure that hanger rods are subject to tensile loading only.
 - .2 Provide linkages where lateral or axial movement of pipework is anticipated.

- .3 Do not use 22 mm or 28 mm rod.
- .7 Pipe attachments: material to MSS SP-58:
 - .1 Attachments for steel piping: carbon steel galvanized.
- .8 Adjustable clevis: material to MSS SP-58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP 58.
- .10 U-bolts: carbon steel to MSS SP 58 with 2 nuts at each end to ASTM A 563.
 - .1 Finishes for steel pipework: black galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: galvanized, with formed portion plastic coated epoxy coated.
- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP 58.

Part 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 Install in accordance with:
 - .1 manufacturer's instructions and recommendations.
- .2 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .3 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .4 Use approved constant support type hangers where:
 - .1 vertical movement of pipework is 13 mm or more,
 - .2 transfer of load to adjacent hangers or connected equipment is not permitted.
- .5 Provide steel saddle for insulated pipe to protect insulation.

3.3 HANGER SPACING

- .1 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m

4	3.7 m	3.6 m
5	4.3 m	
6	4.3 m	
8	4.3 m	
10	4.9 m	
12	4.9 m	

- .2 Pipework greater than NPS 12: to MSS SP 58.

3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.
- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

3.6 FINAL ADJUSTMENT

- .1 Adjust hangers:
 - .1 Ensure that rod is vertical under operating conditions.
 - .2 Equalize loads.
- .2 Adjustable clevis:
 - .1 Tighten hanger load nut securely to ensure proper hanger performance.
 - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
 - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
 - .1 Hammer jaw firmly against underside of beam.

Part 1 - General

1.1 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 National Building Code of Canada.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Provide separate shop drawings for each isolated system complete with performance and product data.
 - .3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .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 NCC Representative will make available 1 copy of systems supplier's installation instructions.
 - .3 Manufacturer's Field Reports: manufacturer's field reports specified.

1.3 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.

2.2 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Cadmium plate for all installations.
- .4 Colour code springs.

2.3 SPRING MOUNT

- .1 Cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M1 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene acoustic pad; built-in resilient limit stops, removable spacer plates.
- .3 Performance: to suit application.

2.4 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
- .2 Type H1 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .3 Performance: to suit application.

2.5 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Provide seismic restraints for all new work required.
 - .2 Seismic control systems to work in every direction.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.
 - .6 Supports of cast iron or threaded pipe not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.

- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
- .4 Piping systems:
 - .1 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .2 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
 - .1 Approved by NCC Representative.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

Part 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 Seismic control measures to meet requirements of NBC.
- .2 Install vibration isolation equipment in accordance with manufacturers instructions and adjust mountings to level equipment.
- .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS4: first 3 points of support. NPS5 to NPS8: first 4 points of support. NPS10 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and requirements for the identification of piping systems, duct work, valves and controllers, including the installation and location of identification systems.

1.2 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.
 - .2 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product data to include paint colour chips, other products specified in this section.
- .2 Samples:
 - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.4 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
 - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.

2.2 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.

2.3 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.

2.4 LANGUAGE

- .1 Identification in English and French.
- .2 Use one nameplate and label for both languages.

Part 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 TIMING

- .1 Provide identification only after insulating and painting.

3.3 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Identify systems, equipment to conform to PWGSC PMSS.

3.4 LOCATION OF IDENTIFICATION ON PIPING SYSTEMS

- .1 On long straight runs in open areas in chiller plant: 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 On both sides of visual obstruction or where run is difficult to follow.
- .4 On both sides of separations such as walls, floors, partitions.
- .5 At beginning and end points of each run and at each piece of equipment in run.
- .6 At point immediately upstream of major manually operated or automatically controlled valves. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .7 Identification easily and accurately readable from usual operating areas and from access points.
 - .1 Position of identification 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 controller: Secure tags with non-ferrous chains or closed "S" hooks.
- .2 Install one copy of flow diagrams, valve schedules mounted where directed by NCC Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.
- .3 Number valves in each system consecutively.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 SUMMARY

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

1.2 QUALIFICATIONS OF TAB PERSONNEL

- .1 Submit names of personnel to perform TAB to NCC Representative within 30 days of award of contract.
- .2 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
 - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002.
 - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-1998.
 - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.
- .3 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .4 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .5 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .6 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .7 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
 - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
 - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

1.3 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 to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.4 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

1.5 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule 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.
- .3 Coordinate TAB with controls, mechanical and electrical contractors.

1.6 PRE-TAB REVIEW

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

1.7 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.

1.8 OPERATION OF SYSTEMS DURING TAB

- .1 Operate systems for length of time required for TAB and as required by NCC Representative for verification of TAB reports.

1.9 START OF TAB

- .1 Notify NCC Representative 14 days prior to start of TAB.
- .2 Start TAB when new work is essentially completed.
- .3 Provisions for TAB installed and operational.
- .4 Start-up, verification for proper, normal and safe operation of 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.

1.10 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 Hydronic systems: plus or minus 10%.
 - .2 All HVAC systems: plus 5%, minus 5%.

1.11 ACCURACY TOLERANCES

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

1.12 INSTRUMENTS

- .1 Prior to TAB, submit to NCC Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within 3 months of TAB. Provide certificate of calibration to NCC Representative.

1.13 ACTION AND INFORMATIONAL SUBMITTALS

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

1.14 PRELIMINARY TAB REPORT

- .1 Submit for checking and approval of NCC 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.

1.15 TAB REPORT

- .1 Format in accordance with Associated Air Balancing Council (AABC/CAABC)
- .2 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.

- .3 Submit 2 copies of TAB Report to NCC Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.16 VERIFICATION

- .1 Reported results subject to verification by NCC Representative.
- .2 Provide personnel and instrumentation to verify up to 30% of reported results.
- .3 Number and location of verified results as directed by NCC Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of NCC Representative.

1.17 SETTINGS

- .1 After TAB is completed to satisfaction of NCC Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

1.18 COMPLETION OF TAB

- .1 TAB considered complete when final TAB Report received and approved by NCC Representative.

1.19 SYSTEMS

- .1 Hydronic Systems: Include both specified and measured data.
 - .1 Air Systems: Include both specified and measured data.
 - .1 Air Handling Equipment:
 - .1 Maximum air flow volume.
 - .2 Fan total pressure.
 - .3 Motor volts, amps and power.
 - .4 Minimum outside air volume.
 - .5 Fan rotational speed.
 - .6 Fan Power, calculate fan efficiency.
 - .7 Inlet and outlet dry bulb, wet bulb and dewpoint temperatures.
 - .8 Equipment static pressure profile.
 - .9 Noise.
 - .10 Vibration.
 - .2 Air Outlets:
 - .1 Outlet location and designation.
 - .2 Manufacturers catalogue identification and type.
 - .3 Air outlet flow factors. Use 1.0 when flow hood is used.
 - .4 Air flow volumes.
 - .5 Deflector vane or diffuser cone settings.
 - .2 Hydronic Systems: Include both specified and measured data..
 - .1 Air Heating and Cooling Coils:
 - .2 Coil type and identification, location and designation.
 - .3 Entering and leaving air dry and wet bulb temperatures.
 - .4 Air static pressure drop.
 - .5 Air flow volume.

- .6 Barometric pressure.
- .7 Air side heat transfer rate.
- .8 Fluid used. Identify fluid used; water, % water/ethylene glycol mixes, steam, etc.
- .9 Fluid flow rate.
- .10 Fluid Specific Heat, at mean temperature.
- .11 Fluid Specific Gravity, at mean temperature.
- .12 Fluid entering and leaving temperatures and pressures.
- .13 Fluid side heat transfer rate.
- .2 Radiant Heaters:
 - .1 Fluid flow rate.

1.20 POST-OCCUPANCY TAB

- .1 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

Part 2 - Products

2.1 NOT USED

- .1 Not used.

Part 3 - Execution

3.1 BALANCING AND ADJUSTING PREPARATION

- .1 Perform testing, adjusting and balancing work after equipment and systems starting procedures have been properly completed.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 01 - Mechanical General Requirements.

1.2 REFERENCES

- .1 Definitions:
 - .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - means "not concealed" as previously defined.
 - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
 - .2 TIAC Codes:
 - .1 CRD: Code Round Ductwork,
 - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
 - .1 ASTM International Inc.
 - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
 - .3 ASTM C449-07(R2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.10-92, Mineral Fibre Board Thermal Insulation.
 - .2 CAN/CGSB-51.11-92, Mineral Fibre Thermal Insulation Blanket.
 - .3 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .3 Manufacturer's Trade Associations: Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
 - .4 Underwriters Laboratories (UL)
 - .1 UL 723, Tests for Surface Burning Characteristics of Building Materials.
 - .5 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures & Section 21 05 01 - Mechanical General Requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.4 SAMPLES

- .1 Submit samples in accordance with Section 21 05 01 - Mechanical General Requirements, if requested by Consultant.
- .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on ½" plywood board. Affix typewritten label beneath sample indicating service.

1.5 MANUFACTURER'S INSTRUCTIONS

- .1 Submit manufacturer's installation instructions in accordance with Section 21 05 01 - Mechanical General Requirements, if requested by Engineer.
- .2 Installation instructions to include procedures to be used, installation standards to be achieved.

1.6 QUALIFICATIONS

- .1 Installer to be specialist in performing work of this section, and have at least 5 years successful experience in this size and type of project, qualified to standards.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Protect from weather and construction traffic.
- .4 Protect against damage from any source.
- .5 Store at temperatures and conditions required by manufacturer.

Part 2 - Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C mean temperature when tested in accordance with ASTM C335/C335M.
- .3 TIAC Code C-1: Rigid mineral fibre board to CAN/CGSB-51.10, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to CAN/CGSB-51.11 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
 - .1 Mineral fibre: to CAN/CGSB-51.11.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/CGSB-51.11.
 - .4 Density: 24 kg/m³.

2.3 JACKETS

- .1 Canvas: 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: Compatible with insulation.
- .4 Acrylic Adhesive (Indoor Applications only):
 - .1 Thickness: 0.18 mm.
 - .2 Finish: Stucco embossed.
 - .3 Peel Adhesion: 18N/25 mm (65 oz./in.)
 - .4 Puncture: 130N (30 lbs.).
 - .5 UL 723 listed (10/20 flame/smoke rating).
 - .6 Acceptable material: VentureClad 1577CW.

2.4 FIRE RATED INSULATION

- .1 ULC listed foil, encapsulated, fire rated, flexible, ceramic fibre insulation, service temperature range to 2200°F, melting point at 3000°F, fire rating of 2 hour with 3" thick blanket.
- .2 Listed for grease duct application where applicable with associated access door accessories.

2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive: Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish: Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .5 Tape: self-adhesive, aluminum, reinforced, 75 mm (3") wide minimum.
- .6 Contact adhesive: quick-setting
- .7 Canvas adhesive: washable.
- .8 Tie wire: 1.5 mm stainless steel.
- .9 Banding: 19 mm (3/4") wide, 0.5 mm thick stainless steel.
- .10 Facing: 25 mm (1") galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .11 Fasteners: 2 mm diameter pins with 38 mm (1½") diameter clips, length to suit thickness of insulation.

Part 3 - Execution

3.1 PRE-INSTALALTION REQUIREMENTS

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

3.2 INSTALALTION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm (3").
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports to be outside vapour retarder jacket.
- .5 Supports, Hangers in accordance with Section 23 05 29 - Bases, Hangers and Supports
 - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: At 300 mm (12") oc in horizontal and vertical directions, minimum two rows each side.

3.3 DUCTWORK INSULATION SCHEDULE

Thickness	TIAC	Vapour Code	Retarder mm (in.)
Rectangular cold and dual temperature supply & return air ducts in exposed areas including silencers (mechanical room, open ceiling, etc.)	C-1	yes	25 (1")
Cold and dual temperature supply air ducts in concealed ceiling space and all round cold ducts including silencers	C-2	yes	25 (1")
Outside air ducts to mixing plenum	C-1	yes	50 (2")
Exhaust ducts within 3 m from roof/ exterior wall penetration	C-1	yes	50 (2")
Acoustically lined ductwork inside building	none		

- .1 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:
 - .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.

.2 Finishes: Conform to following table:

	TIAC Code	
	Rectangular	Round
Indoor, concealed	none	none
Indoor, exposed within mechanical room	CRF/1	CRD/2
Indoor, exposed elsewhere	CRF/1	CRD/2

Part 1 - General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-10, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 ASTM International Inc.
 - .1 ASTM B209M-10, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
 - .2 ASTM C335/C335M-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .3 ASTM C449-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .4 ASTM C547-12, Standard Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S702-09, Thermal Insulation, Mineral Fibre, for Buildings

1.2 DEFINITIONS

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

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 - Products

2.1 FIRE AND SMOKE RATING

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

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702 & ASTM C547.
 - .2 Jacket: to CGSB 51-GP-52Ma.
 - .3 Maximum "k" factor: to CAN/ULC-S702 ASTM C547.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19 mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Hydraulic setting or air drying on mineral wool, to ASTM C449.

2.5 VAPOUR RETARDER LAP ADHESIVE

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

2.6 INDOOR VAPOUR RETARDER FINISH

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

2.7 JACKETS

- .1 PVC:
 - .1 Ontario Building Code compliant for 25/50 flame spread and smoke developed.
 - .2 Minimum thickness 0.038 mm
 - .3 Colour white unless otherwise specified.
 - .4 Non yellowing UV stabilized.
 - .5 Minimum service temperatures: -20°C.
 - .6 Maximum service temperature: 65°C.
 - .7 Moisture vapour transmission: 0.02 perm.
 - .8 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

Part 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 PRE-INSTALLATION REQUIREMENT

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

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

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

3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: SS bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-3.
 - .1 Securements: SS bands at 300 mm on centre.
 - .2 Seals: VR lap seal adhesive, VR lagging adhesive.
 - .3 Installation: TIAC Code: 1501-C.

Applica- tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)				
			Run out	to 1	1-1/4 to 2	2-1/2 to 4	5 to 6
Glycol Heating	350 - 94	A-1	25	25	38	38	38
Glycol switch- over	5 - 59	A-3	25	25	38	38	38
Domestic Hot Water		A-1	25	38	38	38	38
Domestic Cold Water		A-3	25	25	25	25	25
Condensate		A-1	38	50	50	50	50

- .4 Finishes:
 - .1 Exposed indoors: PVC jacket.
 - .2 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
 - .3 Finish attachments: SS bands, at 150 mm on centre. Seals: wing or closed.
 - .4 Installation: to appropriate TIAC code CRF/1 through CPF/5.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Instructions: submit manufacturer's installation instructions.
 - .1 NCC Representative will make available 1 copy of systems supplier's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
 - .2 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
-

Part 2 - Products

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

Part 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 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
 - .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).

- .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design 82 degrees C minimum. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
- .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Check glycol level in expansion tank with cold glycol with circulating pumps OFF and again with pumps ON.
 - .7 Repeat with glycol at design temperature.
 - .8 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
 - .9 Bring system up to design temperature and pressure slowly over a 24 hour period.
 - .10 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
 - .11 Adjust pipe supports, hangers, springs as necessary.
 - .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
 - .13 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
 - .14 Check operation of drain valves.
 - .15 Adjust valve stem packings as systems settle down.
 - .16 Fully open balancing valves (except those that are factory-set).
 - .17 Check operation of over-temperature protection devices on circulating pumps.
 - .18 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Materials and installation for piping, valves and fittings for gas fired equipment.
- .2 Related Requirements
 - .1 Section.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME A120.1-2008, Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance.
 - .2 ASME B16.5-2013, Pipe Flanges and Flanged Fittings.
 - .3 ASME B16.20-2007, Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed.
 - .4 ASME B16.21-2011, Nonmetallic Flat Gaskets for Pipe Flanges.
 - .5 ASME B18.2.1-2012, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA B149.1-10, Natural Gas and Propane Installation Code Handbook.
 - .2 CAN/CSA B149.2-10, Propane Storage and Handling Code.
 - .3 CSA W47.1-00, Certification of Companies for Fusion Welding of Steel.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout Submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 PIPE

- .1 Above ground steel pipe: to ASME A120.1 or ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS ½ to 2, screwed outside, with socket welded fittings inside building.
 - .2 NPS 2½ and over, welded.

2.2 JOINTING MATERIAL

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: to ASME B16.21 or ASME B16.20.

2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Steel butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: Schedule 40, to ASTM A53/A53M.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install in accordance with ASME Boiler and Pressure Vessels Code Section IV, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections recommended by equipment manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer installation instruction for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 All equipment, venting and gas assembly work shall be installed & certified by a provincially certified gas fitter I Level mechanic.

3.2 PIPING

- .1 Install in accordance with applicable Provincial/Territorial Codes.
- .2 Install in accordance with CSA B149.1 and CSA B149.2.
- .3 Assemble piping using fittings manufactured to ASME standards.
- .4 Slope piping down in direction of flow to low points as per Gas Utilization Code.
- .5 Use eccentric reducers at pipe size change installed to provide positive drainage.
- .6 Provide clearance for access and for maintenance.
- .7 Ream pipes, clean scale and dirt, inside and out.
- .8 Install piping to minimize pipe dismantling for equipment removal.

3.3 TESTING

- .1 Test system in accordance with CSA B149.1 and CSA B149.2.
- .2 On existing natural gas services, contractor shall commission TSSA to provide a field inspection of the work. Contractor shall pay all fees & costs, and make application to TSSA fuel branch division. Contractor shall submit Inspection Report to Owner for record. Any orders or non-compliance relating to existing conditions, not relating to the proposed scope of work shall be deemed additional to the contract.

3.4 PURGING

- .1 Purge after pressure test in accordance with CSA B149.1 and CSA B149.2.

3.5 CLEANING AND START-UP

- .1 In accordance with requirements of CSA B149.1 & CSA B149.2.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Copper piping valves and fittings for hydronic systems.
 - .1 Section 22 05 01 - Mechanical General Requirements.
 - .2 Section 23 05 23 - Valves.
 - .3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .4 Section 23 21 13.02 - Steel Piping and Fittings - Hydronic Systems.
 - .5 Section 23 22 13 - Steel Piping and Fittings Steam and Condensate up to 860 kPa.
 - .6 Section 23 25 00 - HVAC Water Treatment Systems where indicated.
 - .7 Section 25 01 11 - Commissioning - Mechanical Systems.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 AWS A5.8/A5.8M:2011, Specification Filler Metals for Brazing and Bronze Welding.
- .2 American National Standards Institute (ANSI) American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.15-2013, Cast Bronze Threaded Fittings: Classes 125 and 250.
 - .2 ASME B16.18-2012, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .3 ASME B16.22-2013, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 American Society for Testing and Materials (ASTM)
 - .1 ASTM B32-08, Specification for Solder Metal.
 - .2 ASTM B88M-13, Specification for Seamless Copper Water Tube Metric.
 - .3 ASTM E202-12, Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 PIPING

- .1 Type L hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ASME B16.15.
- .2 Wrought copper and copper alloy solder joints pressure fittings: to ASME B16.22.
- .3 Cast copper alloy solder joint pressure fittings: to ASME B16.18.

2.3 DI-ELECTRIC COUPLINGS

- .1 Provide wherever pipes of dissimilar metals are jointed.
- .2 For pipe sizes 2 NPS and under, provide di-electric unions or couplings.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to AWS A5.8.
- .3 Brazing: as indicated.

2.5 VALVES

- .1 Refer to Section 23 05 23 - Valves.

Part 3 - Execution

3.1 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .7 Assemble piping using fittings manufactured to ASME standards.

- .8 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .9 Install all pipe wells or other devices supplied by Section 25 01 11 - Commissioning - Mechanical Systems.

3.2 FLUSHING AND CLEANING

- .1 As per Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.3 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment as specified and/or glycol as per Section 23 25 00 - HVAC Water Treatment Systems where indicated.

3.4 TESTING

- .1 Test system in accordance with Section 22 05 01 - Mechanical General Requirements.
- .2 For glycol systems, retest with specified quality of glycol after cleaning. Repair any leaking joints, fittings or valves.

3.5 BALANCING

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Refer to Section 23 05 93 - Testing Adjusting and Balancing of Systems for applicable procedures.

3.6 GLYCOL CHARGING

- .1 Provide mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.
- .3 Provide report to NCC Representative.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes.
 - .1 Materials and installation for steel piping, valves and fittings for hydronic systems in building services piping.
- .2 Related Requirements
 - .1 Section 21 05 01 - Common Work Results for Mechanical.
 - .2 Section 23 05 05 - Installation of Pipework.
 - .3 Section 23 05 17 - Pipe Welding.
 - .4 Section 23 05 23 - Valves.
 - .5 Section 23 05 53.01 - Mechanical Identification.
 - .6 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
 - .7 Section 23 21 13.01 - Copper Piping and Fittings - Hydronic Systems.

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME).
 - .1 ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .2 ASME B16.3-2011, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .3 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - .4 ASME B16.9-2012, Factory-Made Wrought Butt-welding Fittings.
 - .5 ASME B18.2.2-2010, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A47/A47M-99(2009), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .3 ASTM A105/ASTM 105M-11, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - .4 ASTM A139/A139M-04(2010), Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
- .3 American Water Works Association (AWWA).
 - .1 AWWA C111/A21.11-12, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

1.3 QUALITY ASSURANCE

- .1 Health and Safety.
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Waste Management and Disposal.
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
 - .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
 - .4 Fold up metal and plastic banding, flatten and place in designated area for recycling.

Part 2 - Products

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M & ASTM A139/A139M, welded, Grade B carbon steel, as follows:
 - .1 NPS 2-1/2 to 10, Schedule 40.
- .2 Provide openings & wells for new accessories including thermometers, pressure gauges, BAS sensors, drain/test connections, etc.
- .3 Provide pipe identification with flow arrows for all new condenser and chilled water piping in accordance with Section 23 05 53.01 - Mechanical Identification.

2.2 PIPE JOINTS

- .1 Application: glycol systems: NPS 2½ and over; NPS 2 and under shall be copper piping only - no steel piping.
 - .1 NPS 2 and under: shall be copper - refer to Section 23 21 13.01 - Copper Piping and Fittings - Hydronic Systems.
 - .2 Heating and glycol systems NPS 2½ and over: welded or flanged. Grooved joints are not accepted. All underground piping to be welded.
 - .3 Welding fittings and flanges to CSA W47.1. Reference Section 23 05 17 - Pipe Welding.
 - .4 Flanges: full face, weld neck, bored to suit pipe to ASTM A105/105M.
 - .5 Flange gaskets: to AWWA C111/A21.11.
 - .6 Pipe thread: taper.
 - .7 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.
 - .8 Grooved mechanical couplings as manufactured by Victaulic are acceptable as listed. Style 07; ZeroFlex for rigid connections. Style 77 for flexible connections.

2.3 FITTINGS AND ACCESSORIES

- .1 Pipe flanges and flanged fittings:
 - .1 Cast iron: to ASME B16.1.
 - .2 Steel: to ASME B16.5.
- .2 Butt-welding fittings: steel, to ASME B16.9.
- .3 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.
- .4 Steel pipe gaskets, fanges and flanged fittings: to ASME B16.5.
- .5 Couplings, caps, plugs:
 - .1 NPS 1/2 to 1-1/2: Class 3000, 20 MPa, socket weld ends, to ASTM.
- .6 Nipples for drains, vents, pressure gauges, similar items:
 - .1 NPS 1/2 to 1-1/2: Schedule 80, screwed, to ASTM A53/A53M, Grade A.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: Screwed ends.
 - .2 NPS 2-1/2 and larger: Flanged ends.
- .2 Refer to Section 23 05 23 - Valves.

Part 3 - Execution

3.1 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05 - Installation of Pipe Work.

3.2 FLUSHING AND CLEANING

- .1 As per Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

3.3 TESTING

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 83 13 .01 - Snow Melting System.

1.2 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM A278/A278M-01(2011), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 degrees F (350 degrees C).
 - .2 ASTM B62-09, Specification for Composition Bronze or Ounce Metal Castings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for expansion tanks, air vents, separators, valves, and strainers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit maintenance and operation data in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 EXPANSION TANKS

- .1 Vertical steel pressurized expansion tank as per schedule.
 - .2 Bladder in EPDM suitable for 115°C (240°F) operating temperature (glycol).
 - .3 Diaphragm sealed in EPDM suitable for 115°C operating temperature.
 - .4 Working pressure: 862 kPa (125 psi) with ASME stamp and certification including Canadian Registration Number (CRN).
 - .5 Air precharged to initial fill pressure of system as per schedule.
 - .6 Base mount for vertical installation.
 - .7 Supports: Provide supports with hold down bolts and installation templates.
 - .8 Capacity: Sized for fluid volume & operating temperatures.
-

2.2 IN-LINE AIR & DIRT SEPARATOR

- .1 Full flow air eliminator for removal of air and microbubbles and separates dirt simultaneously, c/w manual bleed valve. Mild steel construction, with centre line inlet and outlet ports, copper wire woven mesh & copper tubes inside housing, integrated or separate venting mechanism on top, side valve for floating liquids and debris, and bottom flange c/w threaded blow-down. Maximum working pressure 860 kPa (125 psi), maximum working temperature 175°C (350°F), maximum pressure drop 3 kPa (1 ft.) of water. Provide pipe reducers as required.

2.3 GLYCOL MAKE-UP PACKAGE (GMU)

- .1 The contractor shall supply and install, as indicated on the plans and in the specifications, a prefabricated, automatic and autonomous make-up package for the glycol system.
- .2 The package shall be wall mounted to operate on a standard 120 V, 15 Amp, 60 Hz electrical circuit, and to maintain a fill pressure in the glycol systems as indicated.
- .3 It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate dry contact alarm
- .4 A translucent 25L (6 USgal) polyethylene solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve. Built-in glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.
- .5 The assembly shall be mounted in a sturdy steel wall bracket. It shall include a 0.04 L/s (0.7 USGPM) at free flow pump, 120 V to 24 VDC 50W AC motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, a shut-off valve and a pressure gauge. It shall be connected to the system with a 6 mm (¼") NPT connection. Provide low level alarm panel and contacts.

2.4 AUTOMATIC AIR VENT

- .1 System vents (glycol):
 - .1 Industrial float vent: cast iron body and NPS 3/4 connection and rated at 1034 kPa working pressure.
 - .2 Float: solid material suitable for 115°C working temperature.

2.5 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, Class 250 screwed connections.
- .2 NPS 2-1/2 to 12: cast steel body to ASTM A278M, Class 250, flanged connections.
- .3 Blowdown connection: NPS 1.
- .4 Screen: stainless steel brass with perforations between 5 mm and 6 mm.
- .5 Working pressure: 1034 kPa (150 psi).
- .6 Provide contact for output to BAS for system alarm.

2.6 ETHYLENE GLYCOL

- .1 Provide pre-mixed ethylene glycol in 50% concentration by weight as specified in schedules on drawings for glycol system.

Part 3 - Execution

3.1 GENERAL

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.
- .4 Should deviations beyond allowable clearances arise, request and follow Engineer's directive.
- .5 Check shop drawings for conformance of all tapings for ancillaries and for equipment operating weights.

3.2 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.3 AUTOMATIC AIR VENTS

- .1 Install automatic air vents at high points of piping systems.
- .2 Install full port ball at each automatic air vent.
- .3 Air vents must have minimum connection of 13 mm ($\frac{1}{2}$ ").

3.4 EXPANSION TANKS

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

3.5 PRESSURE SAFETY RELIEF VALVES

- .1 Glycol run discharge pipe to terminate at glycol tank.

3.6 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 MAINTENANCE

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 WET ROTOR CIRCULATING PUMP

- .1 Wet rotor:
 - .1 Integrated pump and motor assembly without shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid.
 - .1 Motor with three speeds,
 - .2 Ceramic radial bearings,
 - .3 Carbon thrust bearing,
 - .4 Stainless steel rotor can, bearing plate and rotor cladding,
 - .5 Stator housing in aluminium alloy,
 - .6 Cast iron or bronze housing,
 - .7 Stator with built-in thermal overload switch.

- .2 In-line cast iron and bronze spiral pump housing:
 - .1 Flange dimensions for USA are according to individual submittal data the flanges have ¼ NPT pressure gauge tapings. Tapped holes are provided on the underside of the pumps. These holes can be used for fitting the pump to a base plate or bracket by means of hexagon screws. The pump housing is provided with a receptacle stainless steel/Teflon neck ring. The ring reduces to a minimum amount of liquid running from the discharge side of the impeller to the suction side.
- .3 Impeller:
 - .1 The impeller is made of stainless steel, AISI 304 SS.
- .4 Motors: High efficiency to Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .5 Design maximum pressure: 860 kPa (125 psi).
- .6 Design maximum temperature: 110°C (230°F).
- .7 Capacity: as per drawing schedule.

Part 3 - Execution

3.1 INSTALLATION

- .1 In line circulators: install as indicated by flow arrows. Support at inlet and outlet flanges or unions. Install with bearing lubrication points accessible. Install motor in orientation as recommended by manufacturer.
- .2 Ensure that pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.
- .3 Pipe drain tapping to nearest floor drain c/w full port ball valve.
- .4 Install volute venting pet cock in accessible location.
- .5 Check rotation prior to start-up.
- .6 Install ball valves on pump suction & discharge tap-ins for pressure gauge.
- .7 All pumps to be installed in accordance with Hydraulic Institute Standards.

3.2 START-UP

- .1 General
 - .1 In accordance with manufacturer's recommendations & Hydraulic Institute Standards.
- .2 Procedures:
 - .1 Before starting pump, check that over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals. Adjust as necessary.
 - .4 Run-in pumps for 12 continuous hours.
 - .5 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .6 Eliminate air from scroll casing.
 - .7 Adjust water flow rate through water-cooled bearings.
 - .8 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .9 Adjust alignment of piping and conduit to ensure true flexibility at all times.
 - .10 Eliminate cavitation, flashing and air entrainment.

- .11 Adjust pump shaft seals, stuffing boxes, glands.
- .12 Measure pressure drop across strainer when clean and with flow rates as finally set.
- .13 Replace seals if pump used to degrease system or if pump used for temporary heat.
- .14 Verify lubricating oil levels.

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 National Fire Protection Association (NFPA).
 - .1 NFPA (Fire) 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems, 2012 Edition.
 - .2 NFPA (Fire) 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems, 2012 Edition.
 - .3 NFPA (Fire) 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations, 2014 Edition.
- .4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 2nd Edition 1995 and Addendum No. 1, 1997.
 - .2 SMACNA HVAC Air Duct Leakage Test Manual, 1985, 1st Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.

1.4 QUALITY ASSURANCE

- .1 Certification of Ratings:
 - .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Protect on site stored or installed absorptive material from moisture damage.

Part 2 - Products

2.1 SEAL CLASSIFICATION

- .1 Classification as follows:

<u>Maximum Pressure Pa</u>	<u>SMACNA Seal Class</u>
500	A
250	A
125	A

- .2 Seal classification:

- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant.

2.2 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 22°F to plus 200°F.
.1 Acceptable material: Duro Dyne S-2.

2.3 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.4 FITTINGS

- .1 Fabrication: to SMACNA.
- .2 Radiused elbows.
.1 Rectangular: standard radius Centreline radius: 1.5 times width of duct.
.2 Round: smooth radius five piece. Centreline radius: 1.5 times diameter.
- .3 Mitred elbows, rectangular:
.1 To 400 mm: with single thickness turning vanes.
.2 Over 400 mm: with double thickness turning vanes.
- .4 Branches:
.1 Rectangular main and branch: with 45 degrees entry on branch.
.2 Round main and branch: enter main duct at 45 degrees with conical connection.
.3 Provide volume control damper in branch duct near connection to main duct.
.4 Main duct branches: with splitter damper.
- .5 Transitions:
.1 Diverging: 20 degrees maximum included angle.
.2 Converging: 30degrees maximum included angle.
- .6 Offsets:
.1 Full radiused elbows.
- .7 Obstruction deflectors: maintain full cross-sectional area.
.1 Maximum included angles: as for transitions.

2.5 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A 653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.6 KITCHEN EXHAUST DUCTWORK

- .1 Stainless steel all welded, c/w access doors in accordance with NFPA (Fire) 96.

2.7 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
 - .1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.
 - .1 Maximum size duct supported by strap hanger: 500 mm.
 - .2 Hanger configuration: to SMACNA.
 - .3 Hangers: black galvanized steel angle with black steel rods to SMACNA following table:

<u>Duct Size</u> (mm)	<u>Angle Size</u> (mm)	<u>Rod Size</u> (mm)
up to 750	25 x 25 x 3	6

- .4 Upper hanger attachments:
 - .1 For concrete: manufactured concrete inserts.

Part 3 - Execution

3.1 GENERAL

- .1 Do work in accordance with NFPA (Fire) 90A, NFPA (Fire) 90B and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods.
 - .1 Insulate strap hangers 100 mm beyond insulated duct.
- .3 Support risers in accordance with ASHRAE and SMACNA .
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

3.2 HANGERS

- .1 Strap hangers: install in accordance with SMACNA.
- .2 Angle hangers: complete with locking nuts and washers.
- .3 Hanger spacing: in accordance with SMACNA as follows:

<u>Duct Size</u> (mm)	<u>Spacing</u> (mm)
to 1500	3000

3.3 SEALING AND TAPING

- .1 Apply sealant to outside of joint to manufacturer's recommendations.

Part 1 - General

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM C177-13, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.10-92, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
- .4 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 90A, Installation of Air Conditioning and Ventilating Systems, 2012 Edition.
 - .2 NFPA (Fire) 90B, Installation of Warm Air Heating and Air Conditioning Systems, 2012 Edition.
- .5 Underwriters' Laboratories of Canada
 - .1 CAN/ULC S102-10, Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.

Part 2 - Products

2.1 DUCT LINER

- .1 General:
 - .1 Fibrous glass or "textile" fibrous glass duct liner: air stream side faced with mat facing.
 - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
- .2 Rigid:
 - .1 Use on flat surfaces where indicated.
 - .2 25 mm (1") thick, to CAN/CGSB-51.10, fibrous glass rigid board duct liner.
 - .3 Density: 36 kg/m³ minimum.
 - .4 Thermal resistance to be minimum 0.76 m².°C/W for 25 mm thickness when tested in accordance with ASTM C177, at 24°C mean temperature.

2.2 FASTENERS

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm square.

2.3 JOINT TAPE

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm wide.

2.4 SEALER

- .1 Meet requirements of NFPA (Fire) 90A and NFPA (Fire) 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68°C to plus 93°C.

Part 3 - Execution

3.1 GENERAL

- .1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.

3.2 DUCT LINER

- .1 Install in accordance with manufacturer's recommendations, and as follows:
 - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
 - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm on centres.

3.3 JOINTS

- .1 Seal all butt joints, exposed edges, weld pin and clip penetrations and all damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's recommendations, and as follows:
 - .1 Bed tape in sealer.
 - .2 Apply 2 coats of sealer over tape.
- .2 Replace badly damaged areas of liner at discretion of Engineer.
- .3 Protect leading and trailing edges of each duct section with sheet metal nosing having 25 mm overlap and fastened to duct.

Part 1 - General

1.1 REFERENCES

- .1 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

Part 2 - Products

2.1 GENERAL

- .1 Manufacture in accordance with SMACNA - HVAC Duct Construction Standards.

2.2 FLEXIBLE CONNECTIONS

- .1 Frame: galvanized sheet metal frame 100 mm thick with fabric clenched by means of double locked seams.
- .2 Material:
 - .1 Fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

2.3 ACCESS DOORS IN DUCTS

- .1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.
- .2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
 - .1 Up to 300 x 300 mm: two sash locks complete with safety chain.
 - .2 301 to 450 mm: four sash locks complete with safety chain.
 - .3 451 to 1000 mm: piano hinge and minimum two sash locks.
 - .4 Doors over 1000 mm: piano hinge and two handles operable from both sides.
 - .5 Hold open devices.

2.4 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
- .2 Cam lock handles with neoprene expansion plug and handle chain.
- .3 28 mm minimum inside diameter. Length to suit insulation thickness.
- .4 Neoprene mounting gasket.

2.5 SPIN-IN COLLARS

- .1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.
- .2 Sheet metal thickness to co-responding round duct standards.

Part 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 data sheet.

3.2 INSTALLATION

- .1 Flexible Connections:
 - .1 Install in following locations:
 - .1 Inlets and outlets to supply air units and fans.
 - .2 Inlets and outlets of exhaust and return air fans.
 - .3 As indicated.
 - .2 Length of connection: 100 mm.
 - .3 Minimum distance between metal parts when system in operation: 75 mm.
 - .4 Install in accordance with recommendations of SMACNA.
 - .5 When fan is running:
 - .1 Ducting on sides of flexible connection to be in alignment.
 - .2 Ensure slack material in flexible connection.
- .2 Access Doors and Viewing Panels:
 - .1 Size:
 - .1 300 x 300 mm for viewing.
 - .2 Location as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Inlets and outlets of other fan systems.

Part 1 - General

1.1 REFERENCES

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-2013.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

Part 2 - Products

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SINGLE BLADE DAMPERS

- .1 Fabricate from same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
 - .2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm (4").
 - .3 For rectangular ducts adjustable lever with shaft extension to accommodate insulation thickness.
 - .4 For round branch ducts adjustable lever with shaft extension to accommodate insulation thickness.
 - .5 Inside and outside nylon end bearings.
 - .6 Channel frame of same material as adjacent duct, complete with angle stop.
-

2.3 MULTI-BLADED DAMPERS

- .1 Factory manufactured of material compatible with duct.
- .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
- .3 Maximum blade height: 100 mm (4").
- .4 Bearings: self-lubricating nylon.
- .5 Linkage: shaft extension with locking quadrant.
- .6 Channel frame of same material as adjacent duct, complete with angle stop.
- .7 Maximum leakage : 0.07% at 750 Pa.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 For supply, return and exhaust systems, locate balancing dampers in each branch duct.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 All dampers to be vibration free.
- .6 Ensure damper operators are observable and accessible.

Part 1 - General

1.1 RELATED SECTIONS

- .1 Section 23 33 00 - Air Duct Accessories.
- .2 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

Part 2 - Products

2.1 ACCEPTABLE MANUFACTURER

- .1 Tamco.
- .2 Nailor.
- .3 Ruskin.
- .4 Ventex.

2.2 MULTI-LEAF DAMPERS

- .1 Opposed blade type as indicated.
 - .2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.
 - .3 Pressure fit self-lubricated bronze bearings.
 - .4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
-

- .5 Control Damper Operators:
 - .1 Electronic:
 - .1 Push-pull proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).
 - .4 Power requirements: as required for application.
 - .5 Operating range: 0 - 20 V DC.
 - .1 Refer to Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
- .6 Performance:
 - .1 Leakage Class: 1A.
 - .2 Pressure drop: at full open position to be less than 4 Pa differential across damper at 5 m/s.
- .7 Insulated aluminum dampers - Exhaust & intake dampers:
 - .1 Frames: insulated with extruded polystyrene foam with R factor of 2.3.
 - .2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 2.3.
- .8 Acceptable material:
 - .1 Exhaust & Intake: Tamco 9000, Ventex.
 - .2 Return: Tamco 1000, Ventex.

2.3 BACK DRAFT DAMPERS

- .1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted, as indicated.

Part 3 - Execution

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Ensure dampers are observable and accessible.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 21 05 00 - Mechanical General Requirements.
- .2 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCES

- .1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
 - .1 NFPA (Fire) 90A, Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 Edition.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S112-10, Fire Test of Fire Damper Assemblies.
 - .2 CAN/ULC S112.2-07, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
 - .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .2 Indicate the following:
 - .1 Fire dampers.
 - .2 Fire stop flaps.
 - .3 Operators.
 - .4 Fusible links.
 - .5 Design details of break-away joints.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .2 Certificates:
 - .1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to codes and standards.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide following:
 - .1 Six (6) fusible links of each type.

1.6 DELIVERY, STORAGE, AND HANDLING

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

Part 2 - Products

2.1 FIRE DAMPERS

- .1 Fire dampers: arrangement Type B, listed and bear label of ULC, meet requirements of provincial fire authority and Fire Commissioner of Canada (FCC) CFFM and NFPA (Fire) 90A. Fire damper assemblies fire tested in accordance with CAN4-S112.
- .2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
 - .1 Fire dampers: 2 hour fire rated unless otherwise indicated.
 - .2 Fire dampers: automatic operating type and have dynamic rating suitable for maximum air velocity and pressure differential to which it will be subjected.
- .3 Top hinged: guillotine type; sized to maintain full duct cross section.
- .4 Fusible link actuated, weighted to close and lock in closed position when released.
- .5 Retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced or as per manufacturers installation requirements.
- .6 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.
- .7 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition or floor slab depth or thickness.
- .8 The installation details given in manufacturer's instructions for fire dampers shall be followed.

Part 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 Install in accordance with NFPA (Fire) 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.
- .5 Co-ordinate with installer of firestopping.
- .6 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation as per manufacturer's installation requirements.

3.3 FIELD QUALITY CONTROL

- .1 Verify proper installation with manufacturer's field representative as per Section 21 05 00 - Mechanical General Requirements.

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Fans, motors, accessories and hardware for commercial use.
- .2 Related Requirements
 - .1 Section 23 05 13 - Motors, Drives and Guards
 - .2 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
 - .3 Section 23 33 00 - Duct Accessories.

1.2 REFERENCES

- .1 Air Movement and Control Association (AMCA)
 - .1 AMCA 99-10, Standards Handbook.
 - .2 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Rating.
 - .3 ANSI/AMCA 300-08, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA 301-06, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 American Bearing Manufacturers Association (ABMA)
 - .1 ANSI/ABMA 9:1990 (R2008), Load Ratings and Fatigue Life for Ball Bearings.
 - .2 ANSI/ABMA 11:1990 (R2008), Load Ratings and Fatigue Life for Roller Bearings.
- .3 ASHRAE/Air Movement and Control Association
 - .1 ANSI/ASHRAE/AMCA 51-2007, Laboratory Methods of Testing Fans for Rating.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
 - .1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide:
 - .1 Fan performance curves showing point of operation, BHP kW and efficiency.
 - .2 Sound rating data at point of operation.
- .3 Closeout Submittals:
 - .1 Provide operation and maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

- .1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Spare parts to include:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

Part 2 - Products

2.1 FANS GENERAL

- .1 Capacity: flow rate, total static pressure, bhp, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
- .2 Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .3 Sound ratings: comply with AMCA 301, tested to AMCA 300. Unit shall bear AMCA certified sound rating seal.
- .4 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51, unit to bear AMCA certified rating seal.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51. Unit shall bear AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.
- .6 Bearings: sealed lifetime oilite ball bearings heavy duty grease lubricated ball or roller bearings of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 200,000 h in accordance with ABMA L50 life standard. Bearings to be rated and selected in accordance with ABMA 9 and ABMA 11.
- .7 Motors:
 - .1 In accordance with Section 23 05 13 - Motors, Drives and Guards supplemented as specified herein.
 - .2 Sizes as indicated.
- .8 Factory primed before assembly in colour standard to manufacturer.
- .9 Scroll casing drains: as indicated.
- .10 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .11 Vibration isolation: to Section 23 05 48 - Vibration Isolation and Seismic Control.

2.2 UPBLAST, KITCHEN ROOF EXHAUSTER

- .1 Upblast centrifugal V-belt driven, meeting the requirements of NFPA (Fire) 96.
- .2 Housing: one piece seamless, heavy gauge aluminum without welding with steel internal support structure & resilient mounted motor and fan.
- .3 Fan: weatherproof self-cleaning with adequate drainage, high velocity vertical discharge. Forced cooled motor compartment with cooling tubes to exterior.

- .4 Impeller: backward inclined, welded wheel, spark resistant non-overloading and dynamically balanced.
- .5 Motor pulleys shall be adjustable for final system balancing. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.
- .6 Adjustable motor sheaves and heavy duty ball bearings.
- .7 12 mm mesh 2.0 m dia. aluminum bird screen with minimum 85% free area.
- .8 Grease collector and separator box, galvanized steel construction.
- .9 Ventilated heavy gauge galvanized curb, 450 mm high, insulated, continuous curb gasket, stainless steel bolts and screws, and flat mounting flange directly mounted to roof surface.
- .10 Custom paint finish. UV and heat resistant.
- .11 Performance: as indicated on drawing schedule.
- .12 Acceptable material: Loren Cook, Greenheck, Penn, Twin City Fan or equal.

2.3 DWDI AIRFOIL CENTRIFUGAL FANS

- .1 Fan wheels: Fan wheels shall have tapered spun wheel cones or shrouds, providing stable flow and high rigidity. Wheels shall be of the non-overloading type. Airfoil wheels shall be die-formed airfoil blade type, continuously welded to the rim and back plate. Blades shall be designed for maximum efficiency and quiet operation. Partial welding will not be acceptable on airfoil blades. Wheels shall be statically and dynamically balanced. The complete fan assembly shall be test balanced at the operating speed prior to shipment.
- .2 Bearings: Heavy duty, anti-friction grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals.
- .3 Housings:
 - .1 Heavy-gauge, continuously welded construction suitably braced to prevent vibration or pulsation. Housings with lock seams or partially welded construction are not acceptable.
 - .2 Aerodynamically designed, spun inlet venturies for smooth airflow into the wheels.
- .4 Shafts: Shafts shall be manufactured of AISI 1040 or 1045 hot rolled steel, accurately turned, ground, polished, and ring gauged for accuracy. Shafts are to be sized for the first critical speed of at least 1.43 times the maximum speed for the class.
- .5 Drives: Cast-iron, fixed pitch motor sheaves for applications 15 HP and larger; variable pitch sheaves for applications of less than 15 HP. Drives should be selected to provide a minimum 1.5 service factor for 30 HP and larger motors.
- .6 Motors: Refer to Section 23 05 13 - Motors, Drives and Guards for Mechanical Systems.
- .7 Performance: as indicated on drawing schedule.
- .8 Acceptable material: Loren Cook, Greenheck, Penn, Twin City Fan.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.

3.2 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces as specified in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

Part 1 - General

1.1 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2013.
- .2 CSA International
 - .1 CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heat exchangers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat exchangers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 EQUIPMENT

- .1 Plate Heat Exchanger:
 - .1 Glycol to glycol.
 - .1 Designed, constructed and tested in with accordance ASME Boiler and Pressure Vessel Code, CSA B51 and provincial pressure vessel regulations.
 - .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
 - .3 Plates: type 304 stainless steel.
 - .4 Gaskets: as recommended by manufacturer to suit fluid temperature.
 - .5 Piping connections: as indicated.
 - .6 Capacity: as indicated in drawing schedule.
 - .7 Dimensions: as indicated in drawing schedule.

Part 3 - Execution

3.1 INSTALLATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
- .3 Plate exchangers: install in accordance with manufacturer's recommendations.

3.2 APPURTENANCES

- .1 Install with safety relief valve piped to glycol tank and hose bib drain valve.
- .2 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.

3.3 SYSTEM START-UP

- .1 Check installation, settings, operation of relief valves and safety valves.
- .2 Check installation, location, settings and operation of operating, limit and safety controls.
- .3 Check supports, seismic restraint systems.

3.4 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 DEMONSTRATION

- .1 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O&M Personnel, supplemented as follows:

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by heat exchanger installation.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 13 - Common Motor Requirements for HVAC Equipment.
- .2 Section 23 05 14 - Variable Frequency Drives.
- .3 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .4 Section 23 34 00 - HVAC Fans.

1.2 REFERENCES

- .1 Air Movement and Control Association (AMCA)
 - .1 AMCA 300-08, Reverberant Method for Sound Testing of Fans.
 - .2 AMCA 301-06 - Method for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 Air-Conditioning, Heating, and Refrigeration Institute (formerly ARI)
 - .1 ARI 260-2011 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
 - .2 ARI 410-2001 - Forced Circulation Air-Cooling and Air-Heating Coils.
 - .3 ARI 430-2009 - Central Station Air Handling Units.
 - .4 ARI 1060-2011 - Performance Rating of Air-To-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 68-1997 - Laboratory Method of Testing to Determine the Sound Power in a Duct.
- .4 American Society for Testing and Materials International (ASTM)
 - .1 ASTM B117-11 - Standard Practice for Operation Salt Spray (Fog) Apparatus.
- .5 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .6 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA MG 1-2011, Motors and Generators, Revision 1.
- .7 National Fire Protection Association (NFPA)
 - .1 NFPA (Fire) 90A - Installation of Air Conditioning and Ventilation Systems, 2012 Edition
 - .2 NFPA (Fire) 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems, 2012 Edition.
- .8 Underwriters Laboratories (UL)
 - .1 UL 900 - Test Performance of Air Filter Units.
 - .2 UL 1995 - Heating and Cooling Equipment.
- .9 AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- .10 SMACNA - HVAC Duct Construction Standards.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for air handling equipment for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide 1 spare sets of filters.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air handling equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

1.7 ACCEPTABLE MATERIALS

- .1 Approved manufacturer:
 - .1 Daikin/Engineered Air or equal.

Part 2 - Products

2.1 GENERAL

- .1 Factory assembled components to form units supplying air at designed conditions, as indicated in plans, schedule & specification.
- .2 Horizontal type, having air tight modular components, consisting of double wall insulated casing, fan section motor and drive, cooling coil, heating coil, filters, mixing box & low leakage outdoor & return air dampers. Shipped loose for field mounting on ductwork where applicable. Sections to be disassembled and reassembled on site to allow access into mechanical room through available opening.
- .3 Provide unit mounting legs to support all sections of unit and raise unit for proper trapping. Contractor will be responsible for providing a housekeeping pad when unit mounting device is not of sufficient height to properly trap unit. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

2.2 CASING

- .1 General:
 - .1 Factory manufactured solid double wall galvanized steel casing construction of 1.3 mm thick steel. Perforated inner casing in fan sections. Reinforced and braced for rigidity and flanged for bolted sub-assemblies, all to withstand a pressure differential from -4" wg to +6" wg.
 - .2 Provide instrument test ports in each section to allow measurement of static pressures after each damper, filters, coil, etc.
 - .1 Instrument Test Ports: 1.6 mm thick steel zinc plated after manufacture c/w Neoprene mounting gasket, Cam lock handles with neoprene expansion plug and handle chain. 28 mm minimum inside diameter. Length to suit insulation thickness.
 - .3 Provide access doors to allow access to internal parts and component removal.
 - .1 Access doors: insulated sandwich panel construction of same material and thickness as casing, of sizes as indicated and complete with 3 hinges, two-way latches and neoprene gaskets as indicated. Hinge doors to open against air pressure complete with hold open devices.
 - .4 Where steel is not galvanized, or where galvanized steel sheet is cut, paint over with corrosion resistant paint to CAN/CGSB-1.181. Finish inside and out, over prime coat, with enamel paint.
 - .5 Internally insulate casing with 50 mm thick, 72 kg/m³ density, neoprene coated rigid acoustic duct liner with metal nosings at all edges, pinned and cemented in place.
 - .6 Openings and bolted sections to be gasketed.

2.3 FANS

- .1 DWDI backwater inclined type to Section 23 34 00 - HVAC Fans.
- .2 Fans shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with in accordance with Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment. Flexible canvas ducts shall be installed between fan and unit casing to ensure complete isolation. Flexible canvas ducts shall comply with NFPA (Fire) 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- .3 Fan modules shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.
- .4 Provide associated variable frequency drive where indicated on schedule in accordance with Section 23 05 14 - Variable Frequency Drives.
- .5 Motors & drives shall be provided in accordance with Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

2.4 COILS

- .1 General:
 - .1 Cleanable tube type: steel or cast iron headers and straight tubes.
 - .2 Coils shall be manufactured with plate fins to minimize water carry over and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
 - .3 All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the

- manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carry over.
- .4 Maximum tube length: 3.6 m unless specified otherwise.
 - .5 Factory proof tested to 300 psig and leak tested to 200 psig with air under water.
 - .6 Provide 20 mm ϕ threaded & capped ports at the top & bottom of each coil header expected through the AHU casing for drawing and blowing out of coil with compressed air.
- .2 Ratings: ARI Certified . Submit with shop drawings actual cooling and heating fluid entering and leaving conditions for stated air side requirements.
 - .1 Unless otherwise indicated, dehumidifying coils shall be rated for 2.5 m/s face velocity.
 - .2 Unless otherwise indicated, preheat coils to be rated for 3.5 m/s.
 - .3 Pressure drop through heating coils: as indicated.
 - .4 Pressure drop through cooling coils: as indicated.
 - .5 Water velocity: 1.2 m/s maximum. Under 0.6 m/s, turbulators may be used if manufacturer's standard practice.
 - .3 Coil casings:
 - .1 Mounting: designed for bolting to other sections.
 - .2 Steel: die formed 1.6 mm thick galvanized zinc coated steel sheet.
 - .3 Tube supports: allow for expansion and contraction.
 - .4 Supports: steel channel or double angle frames or other approved support. Provide brass supports for copper coils.
 - .5 Blank-off plates: of similar material as casing to prevent air bypass. Seal openings where pipes pass through casing using methods recommended by SMACNA.
 - .4 Heating and chilled water glycol coils: cleanable fins.
 - .1 Tubes: copper.
 - .2 Fins: aluminum.
 - .3 Headers: cast iron steel cast brass.
 - .4 Pressure tests: 1.7 Mpa.
 - .5 Supply and return header connections shall be clearly labeled on outside of units such that direction of coil water-flow is counter to direction of unit air-flow.
 - .6 Capacities: as indicated.

2.5 DRAIN PANS

- .1 Construction: stainless steel. Rounded corners.
- .2 Insulation: external foam type, minimum 13 mm thick.
- .3 Drain connection: in bottom at low point.
- .4 Drain pan shall slope in three directions without sag minimum 1% to ensure no standing water at any time or at any point.
- .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include all return bends and headers.
- .6 Provide intermediate drain pans with piped drain to bottom pan whenever coils are stacked.
- .7 The contractor is responsible to ensure the drain pan is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

2.6 FILTER BOX

- .1 Casing as per Clause 2.2.
- .2 Holding frames: galvanized steel or extruded aluminum to suit filter sizes for front servicing.
- .3 Seals: to ensure leakproof operation.
- .4 Blank-off plates: as required, to fit all openings and of same material as holding frames.

2.7 FILTERS

- .1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 120°F.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.
- .4 Filters: disposable, extended surface pleated panel type with welded wire support grid, 2" thick, 3 average efficiency as per ASHRAE 52.
- .5 Size to be 600 x 600 (24" x 24") or 600 x 300 (24" x 12") only.
- .6 Acceptable materials: AAF, Airguard, Farr or equal.

2.8 DAMPERS

- .1 Dampers: opposed blade, low leakage, proportioning type, extruded aluminum blades, 150 mm (6") maximum width, locked to steel rods in rustproof bushings.
 - .1 Performance:
 - .1 Leakage Class: 1A.
 - .2 Pressure drop: at full open position to be less than 4 Pa differential across damper at 5 m/s.
 - .2 Seals: Neoprene on damper edges, top, bottom, sides of framing.
 - .3 Acceptable material: Outdoor Intake & Exhaust Damper: TAMCO 9000 or equal. Return & Bypass Damper: Tamco 1000 or equal.

2.9 VIBRATION ISOLATION

- .1 Flexible Connections:
 - .1 Frame: galvanized sheet metal frame 100 mm thick with fabric clenched by means of double locked seams.
 - .2 Material: fire resistant, self extinguishing, neoprene coated glass fabric, temperature rated at minus 40°C to plus 90°C, density of 1.3 kg/m².
- .2 Vibration Isolator on Supply Fan:
 - .1 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
 - .2 Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

2.10 ACCESSORIES

- .1 Provide air tight 12 mm diameter sleeves for control wiring to sensors in fan plenum, coil section, across filter section, and mixing box sections. Provide additional 38 mm diameter sleeve in the fan plenum for power wiring to fan. All locations will be selected by engineer on shop drawings and installed in contractor's shop.
- .2 Provide factory mounted Dwyer 2000 magnehelic pressure gauges, accurate to +2% full range sensing, complete with sensing probes and shut-off valves, one per filter bank.
- .3 All control functions to be executed by networked PLC provided by Controls Contractor.
- .4 Provide factory mounted freeze-stat on downstream side of heating coil.

2.11 SOUND POWER LEVELS (dB)

- .1 Schedule

System	Fan	Location	63	125	250	500	1000	2000
AHU-1	Supply	Discharge	84	77	81	90	85	84
	Return	Inlet	80	80	88	87	80	75

Part 3 - Execution

3.1 INSTALLATION

- .1 Unit shall be shipped to site in sections no larger than 1,200 mm to fit door openings.
- .2 Provide manufacturer representative to supervise the field assembly by the contractor.
- .3 Assemble to provide smooth air flow through all components. Limit air leakage to 1% of rated air flow at 2.5 kPa suction pressure.
- .4 Apply sealer into all seams prior to assembly. Secure toe angles on 300 mm centres for full length of casing.
- .5 Paint inside casing surfaces with zinc coating to CAN/CGSB-1.181, 0.075 mm minimum thickness when dry.

3.2 FANS

- .1 Provide sheaves and belts required for final air balance.
- .2 Install flexible connections at fan inlet. Ensure metal bands of connectors are parallel and not touching when fan is running and when fan is stopped. Ensure that fan inlet and duct are aligned when fan is running.
- .3 Install spring isolators on supply fan with 2" deflection.

3.3 DRIP PAN

- .1 Install deep seal P trap on drain pan discharge. Trap size and depth to be sized to manufacturer's recommendations and reviewed by Engineer prior to installation.

Part 1 - General

1.1 REFERENCES

- .1 All components selected for this project shall conform to the following market Standards:
 - .1 AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .2 ANSI/ASHRAE 90.1-2010 (SI), ANSI/ASHRAE/IES Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings (SI Edition).
 - .3 ANSI/ASHRAE 52.2-2012, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .4 CSA B149.1-10, Natural gas and propane installation code, Includes Update No. 1 (2010).
 - .5 CAN/CSA C746-06(R2012), Performance Standard for Rating Large and Single Packaged Vertical Air Conditioners and Heat Pumps.
 - .6 NEMA MG 1, National Electrical Manufacturers Association Motor Standards.
 - .7 NFPA (Fire) 54 / ANSI Z223.1, National Fuel Gas Code, 2009 Edition, Includes Amendment A (2009) and Amendment B (2010).
 - .8 NFPA (Fire) 90A Standard for the Installation of Air Conditioning and Ventilating Systems, 2012 edition.
 - .9 UL 1812, Ducted Heat Recovery Ventilators.

1.2 QUALITY ASSURANCE

- .1 Unit manufacturer shall have a minimum of 15 years experience in the heat recovery market.
- .2 The system shall deliver the specified air volume at the static pressure scheduled.
- .3 The unit shall be constructed in a way to provide smooth interior surfaces and to limit the casing leakage at less than 1% of the specified air volume at operating static.
- .4 Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL label of approval.
- .5 Unit shall be constructed in accordance with industrial design practices.
- .6 Insulation shall comply with NFPA (Fire) 90A requirements for flame spread and smoke generation.
- .7 Airflow data shall comply with AMCA 210 method of testing.
- .8 Cabinet and exterior components shall be tested and certified weatherproof.
- .9 All units shall be 100% factory tested.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Unit shall be stored and handled per manufacturer's recommendations. See manufacturer installation procedures, maintenance and operation manuals for an adequate installation.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate:
 - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

- .2 Piping, valves, fitting shipped loose showing final location in assembly.
- .3 Control equipment shipped loose, showing final location in assembly.
- .4 Complete internal panel pneumatic tube piping and wiring and any external panel pneumatic tube piping and wiring, both as schematics and as actually assembled.
- .5 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
- .6 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
- .7 Fan performance curves.
- .8 Details of vibration isolation.
- .9 Estimate of sound levels to be expected across each individual octave band in dB referred to A rating.

1.5 MAINTENANCE DATA

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Indicate:
 - .1 Brief description of unit, indexed, with details of function, operation, control, and service for each component.
- .3 Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance and service of items. Include names and addresses of spare part suppliers.
- .4 Include following:
 - .1 Provide for each unit, manufacturer's name, type, year, number of units, and capacity.

1.6 WARRANTY

- .1 Contractor hereby warrants refrigeration compressors for 5 years.
- .2 Manufacturer to provide a one (1) year warranty on all parts, and 5 years on the enthalpy wheel excluding labor. Warranty of less duration is not acceptable.

1.7 MANUFACTURED ITEMS

- .1 Catalogued or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards in force.

Part 2 - Products

2.1 GENERAL

- .1 Make-up air units shall be built to the level of quality as herein specified and to the description of the Equipment Schedule.
- .2 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equal" or "alternate" must address these factors.
- .3 Unless stated otherwise, make-up air units are to be shipped to the job in one piece, factory assembled. Modular units assembled to achieve a close approximation to the intent of this specification will not be

considered equal. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as CETL, ETLUS, UL, CSA prior to shipment.

- .4 Pre-wired units shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.
 - .1 Unit must conform to regulations set out in the Canadian Energy Efficiency Act for large air conditioners (condensing units). Packaged units shall be tested to CSA C746 and must bear an EEV (energy efficiency verification) label provided by CSA.
 - .2 "Where specified as factory packaged air conditioning unit, factory assembled split systems do not conform to the Canadian Energy Efficiency Act and will not be considered."
- .5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.
- .6 The units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of fifteen continuous years of proven production experience.
- .7 Units shall be as manufactured by Engineered Air or approved equal.

2.2 UNIT CONSTRUCTION

- .1 Unit casing shall be of minimum 16 gauge (1.6 mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electro- statically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated. Architectural finish on units to be PPG Duranar UC45074.
- .2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.
- .3 The following components shall be provided with a 22 gauge (.8 5mm) solid, or 24 gauge (.70 mm) perforated (40% free area) galvanized metal liner over insulated areas:

	Solid Liner	Perf. Liner
- Fan Sections	_____	__x__
- Coil Sections	__x__	_____
- Filter Sections	__x__	_____
- Access Sections	__x__	_____

- .4 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, electrical control panels, burner compressor compartments. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.
- .5 Units shall be provided with hinged access doors, with extruded neoprene gasket, fully lined, and a minimum of two Leverlok handles, operable from both sides for all units.
- .6 All units shall be internally insulated with:
 - .1 2" (51 mm) thick 1-1/2 lbs./cu.ft. (24 kg/cu.m.) density, neoprene coated fibre glass thermal insulation.
 - .2 1-1/2 lbs./cu.ft. (24 kg/cu.m.) insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 16" (400 mm) o/c. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.
- .7 Provide full perimeter seismic roof mounting curb of heavy gauge sheet metal, minimum of 18" (450 mm) high, and complete with wood nailer, neoprene sealing strip, and fully welded "Z" bar with 1" (25 mm) upturn on inner perimeter, to provide a complete seal against the elements. External insulation of the roof-mounting

curb shall be provided by the Roofing Subcontractor. Contractor to provide seismic restraint calculations from P.Eng. for all equipment connections to the structure.

2.3 FANS

- .1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.
- .2 Airfoil fans shall be equipped with greaseable, self-aligning ball type pillow block bearings. Maximum outlet velocity not to exceed 2500 FPM
- .3 Drives shall be adjustable on fans with motors 7½ HP (5.6 kW) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.
- .4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9" (230mm) to 15" (380 mm) diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 1" (25 mm) static deflection designed to achieve high isolation efficiency. Provide seismic restraint type isolators containing compressed spring. Use of separate bumper or snubber is not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.
- .5 Fan motors shall be ODP super high efficiency, suitable for variable frequency drives with shaft grounding rings.

2.4 GAS HEAT SECTION - INDIRECT FIRED

- .1 General:
 - .1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority and carry the approval label of that authority as a complete operating package.
 - .2 All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.
 - .3 Operating natural gas pressure at unit(s) manifold shall be 7"w.c.(1750 Pa)
- .2 Heat Exchanger/Burner Assembly:
 - .1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane metal turbulators and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 1"(25mm) of insulation between the outer cabinet and inner heat reflective galvanized steel liner. Blower location shall be engineered to improve the required air flow pattern around the heat exchanger. Using duct type furnaces and closed coupled blowers are not acceptable.
 - .2 Units with optional high efficiency heat exchangers (DJX) shall be tested and certified to ANSI/CSA standards to provide a minimum of 90% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.
 - .3 90% efficiency condensing burner c/w shipped loose neutralizing tank installed by contractor.
 - .4 The heat exchanger/burner assembly shall be a blow through positive pressure type. Units incorporating the DJM module shall have an interrupted pilot ignition system to provide increased safety. Units using continuous or intermittent pilots are not acceptable.

- .5 Flame surveillance shall be from the main flame after ignition not the pilot flame. The burner and gas train shall be in a cabinet enclosure. Atmospheric burners or burners requiring power assisted venting are not acceptable.
- .6 The heat exchanger/burner assembly shall include 15:1 turndown for all input ranges from 100 MBH to 1400 MBH (29.3 kW to 410 kW). The high turn down heat exchanger/burner assembly minimum input shall be capable of controlling 6.7% of its rated input, excluding the pilot assembly, without on/off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from high to low fire.
- .3 Factory testing of indirect fired gas heating section:
 - .1 Tests shall be performed after complete final unit assembly, just prior to shipping to job site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.
 - .1 Heat exchanger shall be clocked with a dedicated calibrated gas meter to insure proper set up of the gas manifold.
 - .2 High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O₂ and CO to provide proper air fuel ratio throughout the entire operating range.
 - .3 A copy of the combustion test report shall be provided.
- .4 Venting:
 - .1 Installation and venting provisions must be in accordance with CSA B149.1, NFPA (Fire) 54 / ANSI Z223.1, and local authorities having jurisdiction.
- .5 Controls:
 - .1 Electronic DJM module (Modulating Fuel w/ Modulating Combustion Air) complete with proportional and integral control with discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed varies proportionally in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions. Combustion blower RPM shall be proved using a hall effect speed sensor. Two speed or step speed combustion blowers are not acceptable.
 - .2 Combustion efficiency of high efficiency heat exchangers shall increase by up to 4-5% from high fire to low fire while turning down on units incorporating 15:1 turndown (HT Burner). Heat exchangers shall provide a minimum of 90% efficiency throughout the entire operating range.
 - .3 Heat exchangers with input ranges 400 MBH and lower shall provide a minimum of 90% efficiency throughout the entire operating range.
 - .4 Alternate manufacturers units that do not incorporate a variable speed combustion air blower shall have a modulating gas valve and a combustion air damper with a linear linkage connected to an actuator which has a minimum of 100 steps of control.
 - .5 Controllers for heating only units incorporating the DJM3 module shall include the following standard features:
 - .1 Service analyzer with diagnostic lights for ease of set-up and service
 - .2 linear gas and combustion air flow obtained via a built in solid-state linear algorithm
 - .3 -40°F(-40°C) minimum operating ambient temperature
 - .4 four air change pre-purge on units with over 400 MBH(117 kW) input
 - .5 maintained purge to decrease temperature cycles
 - .6 post purge
 - .7 interrupted pilot
 - .8 self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances
 - .9 low fire start
 - .10 controlled burner start-up and shut down
 - .11 blower contactor that starts fan after burner prepurge
 - .12 economizer enable control
 - .13 damper contact that allows fan to start after damper opens, damper to close after fan stops, and damper to close on flame failure
 - .14 non-recycling auto by-pass low limit with alarm contacts and built-in sensor checking
 - .15 built-in alternate blower and damper functions and set back temperatures for unoccupied mode operation using a single room thermostat

- .16 separate gas and air actuators independently controlled to give the correct air to fuel ratio throughout the entire firing range.
- .6 Heating control function shall be modulating discharge air with 0-10 VDC BMS reset. Minimum discharge air set point is 50°F (10°C) if BMS control signal fails.
- .7 Discharge air sensor shall be field mounted in supply ductwork.
- .8 Provide a make up air reverse airflow high limit switch in series with the standard high limit switch mounted in the blower discharge.

2.5 FILTERS

- .1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the drawings.
- .2 The filter modules shall be designed to slide out of the unit. Side removal 1" (25 mm) or 2" (50 mm) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.
- .3 2" (50 mm) Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fibre media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. The filter media shall have a minimum efficiency of 20-25% on ASHRAE 52.2, and a minimum of MERV 6 per ASHRAE 52.2. Rated U.L. Class 2.
- .4 Provide one (1) set of filters with unit and two (2) sets of spare filters, Contractor to allow for change out of filters at time of turnover.

2.6 DAMPERS

- .1 Damper frames shall be U-shaped galvanized metal sections securely screwed or welded to the air handling unit chassis. Pivot rods of ½" (13 mm) aluminum shall turn in nylon or bronze bushings. Rods shall be secured to the blade by means of straps and set screws.
- .2 Blades shall be 18 gauge (1.3 mm) galvanized metal with two breaks on each edge and three breaks on centerline for rigidity. The pivot rod shall "nest" in the centerline break. Damper edges shall interlock. Maximum length of damper between supports shall be (1210 mm). Damper linkage brackets shall be constructed of galvanized metal.
- .3 Dampers shall be:
 - .1 Thermally broken, insulated dampers on outdoor air dampers. test laboratory. These dampers include: rigidly formed galvanized steel frame with corner reinforcing brackets, heavy duty galvanized damper blades secured with bolts to continuous ½"(13 mm) aluminum drive rods, all weather PVC double seal blade gasket, tempered aluminum alloy blade end seal, epoxy enamel coated, oil impregnated bronze bushings, and non-corrosive smooth acting linkage.
 - .2 Certified low leak dampers shall also be provided for return air dampers.

2.7 FACTORY SUPPLIED CONTROLS/WIRING

- .1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.
- .2 Fire alarm circuits shall be powered from a relay in unit circuitry.
- .3 Factory installed and wired non-fused disconnect switch in CEMA/NEMA configuration, or disconnect with integral door closure mounted on face of control panel.

- .4 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.
- .5 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

2.8 ROOF CURBS

- .1 Roof curbs shall be constructed by structural concrete. External insulation of the roof mounting curb shall be provided by roofing subcontractor. Units are to be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit.
- .2 The unit must be solidly fastened to the top rail and anchored to the roof structure. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience.

2.9 PERFORMANCE

- .1 As indicated on schedule drawing.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install as per manufacturers' instructions on roof curbs provided by manufacturer.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.
- .3 Submit startup report for Engineer's review.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 25 05 01 - EMCS: General Requirements.

1.2 DEFINITIONS

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
 - .1 Outage of main power supply in excess of back-up power sources, provided that:
 - .1 Automatic initiation of back-up was accomplished.
 - .2 Automatic shut-down and re-start of components was as specified.
 - .2 Failure of communications link, provided that:
 - .1 Controller automatically and correctly operated in stand-alone mode.
 - .2 Failure was not due to failure of any specified EMCS equipment.
 - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
 - .1 System recorded said fault.
 - .2 Equipment defaulted to fail-safe mode.
 - .3 AEL of total of all input sensors and output devices is at least 99% during test period.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Final Report: submit report to NCC Representative.
 - .1 Include measurements, final settings and certified test results.
 - .2 Bear signature of commissioning technician and supervisor
 - .3 Report format to be approved by NCC Representative before commissioning is started.
 - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to NCC Representative in accordance with Section 01 78 00 - Closeout Submittals.
 - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide documentation, O&M Manuals, and training of O&M personnel for review of NCC Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

1.5 COMMISSIONING

- .1 Do commissioning of all control systems associated with new fan coil system, exhaust fan and radiant heaters.
- .2 Carry out commissioning under direction of NCC Representative and in presence of NCC Representative.

- .3 Inform, and obtain approval from, NCC Representative in writing at least 14 days prior to commissioning or each test. Indicate:
 - .1 Location and part of system to be tested or commissioned.
 - .2 Testing/commissioning procedures, anticipated results.
 - .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of NCC Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Load system with project software.
- .7 Perform tests as required.

1.6 COMPLETION OF COMMISSIONING

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by NCC Representative.

1.7 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

Part 2 - Products

2.1 EQUIPMENT

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances : higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

PART 3 - EXECUTION

3.1 PROCEDURES

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by a qualified commissioning professional and approved by NCC Representative.
- .3 Commission integrated systems using procedures prescribed by a qualified commissioning professional and approved by NCC Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

3.2 FIELD QUALITY CONTROL

- .1 Completion Testing.
 - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
 - .2 Include following activities:
 - .1 Test and calibrate field hardware including stand-alone capability of each controller.
 - .2 Verify each A-to-D convertor.
 - .3 Test and calibrate each AI using calibrated digital instruments.
 - .4 Test each DI to ensure proper settings and switching contacts.
 - .5 Test each DO to ensure proper operation and lag time.
 - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
 - .7 Test operating software.
 - .8 Test application software and provide samples of logs and commands.
 - .9 Verify each CDL including energy optimization programs.
 - .10 Debug software.
 - .11 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and NCC Representative . This document will be used in final startup testing.
 - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of NCC Representative and provide:
 - .1 2 technical personnel capable of re-calibrating field hardware and modifying software.
 - .2 Detailed daily schedule showing items to be tested and personnel available.
 - .3 NCC Representative's acceptance signature to be on executive and applications programs.
 - .4 Commissioning to commence during final startup testing.
 - .5 O&M personnel to assist in commissioning procedures as part of training.
 - .6 Commissioning to be supervised by qualified supervisory personnel and NCC Representative.
 - .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
 - .8 Operate systems as long as necessary to commission entire project.
 - .9 Monitor progress and keep detailed records of activities and results.
 - .4 NCC Representative to verify reported results.

3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by NCC Representative, set and lock devices in final position and permanently mark settings.

3.4 DEMONSTRATION

- .1 Demonstrate to Commissioning Manager NCC Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 25 05 54 - EMCS: Identification.
- .2 Section 25 90 01 - EMCS: Site Requirements, Applications and Systems.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
 - .1 ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
- .2 Institute of Electrical and Electronics Engineers (IEEE).
 - .1 IEEE 260.1-2004, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 Canadian Standards Association (CSA International).

1.3 ACRONYMS AND ABBREVIATIONS

- .1 Acronyms used in EMCS:
 - .1 AEL - Average Effectiveness Level.
 - .2 AI - Analog Input.
 - .3 AIT - Agreement on International Trade.
 - .4 AO - Analog Output.
 - .5 BACnet - Building Automation and Control Network.
 - .6 BC(s) - Building Controller(s).
 - .7 BECC - Building Environmental Control Center.
 - .8 CAD - Computer Aided Design.
 - .9 CDL - Control Description Logic.
 - .10 CDS - Control Design Schematic.
 - .11 COSV - Change of State or Value.
 - .12 CPU - Central Processing Unit.
 - .13 DI - Digital Input.
 - .14 DO - Digital Output.
 - .15 DP - Differential Pressure.
 - .16 ECU - Equipment Control Unit.
 - .17 EMCS - Energy Monitoring and Control System.
 - .18 HVAC - Heating, Ventilation, Air Conditioning.
 - .19 IDE - Interface Device Equipment.
 - .20 I/O - Input/Output.
 - .21 ISA - Industry Standard Architecture.
 - .22 LAN - Local Area Network.
 - .23 LCU - Local Control Unit.
 - .24 MCU - Master Control Unit.
 - .25 NAFTA - North American Free Trade Agreement.
 - .26 NC - Normally Closed.
 - .27 NO - Normally Open.
 - .28 OS - Operating System.
 - .29 O&M - Operation and Maintenance.
 - .30 OWS - Operator Work Station.
 - .31 PC - Personal Computer.
 - .32 PCI - Peripheral Control Interface.
 - .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.

- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.
- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.
- .41 VAV - Variable Air Volume.

1.4 DEFINITIONS

- .1 Point: may be logical or physical.
 - .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
 - .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
 - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.
 - .1 Area descriptor: building or part of building where point is located.
 - .2 System descriptor: system that point is located on.
 - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide 25character field for each point identifier.
 - .2 Point expansion : comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.
 - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
 - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
 - .1 AI (analog input).
 - .2 AO (analog output).
 - .3 DI (digital input).
 - .4 DO (digital output).
 - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
 - .1 Printouts: to IEEE 260.1.
 - .2 Refer also to Section 25 05 54 - EMCS: Identification.

1.5 SYSTEM DESCRIPTION

- .1 Refer to Section 25 90 01 - EMCS: Site Requirements, Applications and Systems.
- .2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
 - .1 Building Controllers.
 - .2 Control devices as listed in I/O point summary tables.
 - .3 OWS(s).
 - .4 Data communications equipment necessary to effect EMCS data transmission system.

- .5 Field control devices.
 - .6 Software/Hardware complete with full documentation.
 - .7 Complete operating and maintenance manuals.
 - .8 Training of personnel.
 - .9 Acceptance tests, technical support during commissioning, full documentation.
 - .10 Wiring interface co-ordination of equipment supplied by others.
 - .11 Miscellaneous work as specified in these sections and as indicated.
- .3 General Requirements:
- .1 Provide conduit and wiring linking elements of system.
 - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by NCC Representative prior to installation.
 - .3 Location of controllers as reviewed by NCC Representative prior to installation.
- .4 Language Operating Requirements:
- .1 Provide English and French operator selectable access codes.
 - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English and French.
 - .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English and French.
 - .4 System manager software: include in English and French system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
 - .5 Include, in English and French:
 - .1 Input and output commands and messages from operator-initiated functions and field related changes and alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-definitions).
 - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points.
 - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit for review:
 - .1 Equipment list and systems manufacturers at time of tender within 48 h after award of contract.
- .3 Quality Control:
 - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
 - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
 - .3 Submit proof of compliance to specified standards with shop drawings and product data
 - .4 In lieu of such evidence, submit certificate from testing organization, approved by NCC Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
 - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
 - .6 Permits and fees: in accordance with general conditions of contract.
 - .7 Submit certificate of acceptance from authority having jurisdiction to NCC Representative.
 - .8 Existing devices intended for re-use: submit test report.

1.7 QUALITY ASSURANCE

- .1 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.
- .2 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .3 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 30 - Health and Safety.

1.8 EXISTING - CONTROL COMPONENTS

- .1 All building automation controls shall be performed by Siemens Building Technologies.
- .2 All new material and equipment to be compatible with the existing BAS (Siemens Apogee System).

Part 2 - Products

2.1 EQUIPMENT

- .1 All materials must be selected to ensure full compatibility with existing BAS system.
- .2 Complete list of equipment and materials to be used on project and forming part of bid tender documents by adding manufacturer's name, model number and details of materials, and submit for approval.

2.2 ADAPTORS

- .1 Provide adaptors between metric and imperial components.

Part 3 - Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

- .1 Installation: to manufacturer's recommendations.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 23.01 - Valves.
- .2 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
- .3 Section 25 05 01 - EMCS: General Requirements.
- .4 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
- .5 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 National Electrical Manufacturer's Association (NEMA).
- .2 Canadian Standards Association (CSA International).

1.3 DEFINITIONS

- .1 Acronyms and Definitions: refer to Section 25 05 01 - EMCS: General Requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 01 33 00 - Submittal Procedures.

1.5 EXISTING CONDITIONS

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.

Part 2 - Products

2.1 GENERAL

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, heat resistant, assembly.
- .3 Operating conditions: -40 - 40 degrees C with 10 - 90% RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.

- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.
- .8 Range: including temperature, humidity, pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

2.2 TEMPERATURE SENSORS

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
 - .1 Thermocouples: limit to temperature range of 200 degrees C and over.
 - .2 RTD's: 100 or 1000 ohm at 0 degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.
 - .3 Sensing element: hermetically sealed.
 - .4 Stem and tip construction: copper or type 304 stainless steel.
 - .5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.
 - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor.
- .2 Room temperature sensors and display wall modules.
 - .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Jack connection for plugging in laptop personal computer for access to zone bus.
 - .4 Integral thermistor sensing element 10,000 ohm at 24 degrees.
 - .5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
 - .6 Stability 0.02 degrees C drift per year.
 - .7 Separate mounting base for ease of installation.
- .3 Duct temperature sensors:
 - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
 - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:
 - .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
 - .1 Input circuit: to accept 3-lead, 100 ohm at 0°C, platinum resistance detectors type sensors.
 - .2 Power supply: 575 ohms at 24 V DC into load of 575 ohms. Power supply effect less than 0.01°C per volt change.
 - .3 Output signal: 4 - 20 mA into 500 ohm maximum load.
 - .4 Input and output short circuit and open circuit protection.
 - .5 Output variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.
 - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full scale output.
 - .7 Maximum current to 100 ohm RTD sensor: not to exceed 25 mA.
 - .8 Integral zero and span adjustments.
 - .9 Temperature effects: not to exceed plus or minus 1.0% of full scale/ 50°C.

- .10 Long term output drift: not to exceed 0.25% of full scale/ 6 months.
- .11 Transmitter ranges: Select narrowest range to suit application from following:
 - .1 Minus 50°C to plus 50°C, plus or minus 0.5°C.
 - .2 0 to 100°C, plus or minus 0.5°C.
 - .3 0 to 50°C, plus or minus 0.25°C.
 - .4 0 to 25°C, plus or minus 0.1°C.
 - .5 10 to 35°C, plus or minus 0.25°C.

2.4 ELECTRICAL RELAYS

- .1 Requirements:
 - .1 Double voltage, DPDT, plug-in type with termination base.
 - .2 Coils: rated for 120V AC or 24V DC. Other voltage: provide transformer.
 - .3 Contacts: rated at 5 amps at 120 V AC.
 - .4 Relay to have visual status indication.

2.5 CONTROL VALVES

- .1 Requirements:
 - .1 Construction: reference Section 23 05 23.01 - Valves.
 - .2 Two or three port as indicated. Normally Open.
 - .3 Flow characteristics: linear or equal percentage as indicated.
 - .4 Rangeability: 50:1 minimum.
 - .5 Performance: refer to drawings for capacities.
 - .6 Minimum shut-off pressure: refer to drawings and valve specifications.
 - .7 Size for 25% of system pressure drop or 5 psi, whichever is less.
 - .8 Two position valves shall be line size.

2.6 ELECTRONIC VALVE ACTUATORS

- .1 Requirements:
 - .1 Construction: steel, cast iron, aluminum.
 - .2 Control signal: 4-20 mA DC.
 - .3 Return to normal position on loss of communication.
 - .4 Positioning time: to suit application (90 seconds maximum).
 - .5 Size actuator to meet requirements and performance of control valve specifications.
 - .6 Scale or dial indication of actual control valve position.

2.7 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
 - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
 - .2 Output signal: 4-20 mA into 500 ohm maximum load.
 - .3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
 - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effects: not to exceed plus or minus 1.5% full scale/50 degrees C.
 - .7 Over-pressure input protection to at least twice rated input pressure.
 - .8 Output short circuit and open circuit protection.
 - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.8 CURRENT / PNEUMATIC (I/P) TRANSDUCERS

- .1 Requirements:
 - .1 Input range: 4 to 20 mA.
 - .2 Output range: proportional 20-104 kPa or 20-186 kPa as applicable.
 - .3 Housing: dustproof or panel mounted.
 - .4 Internal materials: suitable for continuous contact with industrial standard instrument air.
 - .5 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 2% of full scale over entire range.
 - .6 Integral zero and span adjustment.
 - .7 Temperature effect: plus or minus 2% of full scale/ 50 degrees C or less.
 - .8 Regulated supply pressure: 206 kPa maximum.
 - .9 Air consumption: 16.5 ml/s maximum.
 - .10 Integral gauge manifold c/w gauge (0-206 kPa).

2.9 ELECTRONIC CONTROL DAMPER ACTUATORS

- .1 Requirements:
 - .1 Direct mount proportional type as indicated.
 - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
 - .3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.
 - .4 Power requirements: 5 VA maximum at 24 V AC.
 - .5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.
 - .6 For VAV box applications floating control type actuators may be used.

2.10 FREEZESTATS

- .1 Install freezestats on fan coil. Freezestat to be equipped with local LED indicating light.
 - .1 Upon detection of low temperature, the freezestats shall stop the associated supply and exhaust fans. Provide manual reset.

2.11 WIRING

- .1 Wiring must be continuous without joints.
- .2 All wiring to be in EMT conduits.
- .3 Sizes:
 - .1 Field wiring to digital device: #18AWG or 20AWG stranded twisted pair.
 - .2 Analog input and output: shielded #18 minimum solid copper #20 minimum stranded twisted pair.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping. Maintain fire rating integrity.
- .6 Electrical:
 - .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
 - .3 Trace existing control wiring installation and provide updated wiring schematics including additions and deletions to control circuits before beginning Work.
 - .4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
 - .5 Install communication wiring in conduit.
 - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
 - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
 - .3 Maximum conduit fill not to exceed 40%.
 - .4 Design drawings do not show conduit layout.
 - .6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 ELECTRICAL WIRING AND MATERIALS

- .1 Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings, and related wiring accessories. All conduit, wiring and equipment to conform to Div. 26 specifications.
- .2 Provide wiring between thermostats, aquastats and unit heater motors, all control and alarm wiring for all control and alarm devices for all Sections of Specifications. Controls Contractor shall be responsible for all controls and interlock wiring not covered by Div. 26, including but not limited to air proving switches, end switches, alarm devices and other control components.
- .3 All 120V power shall be provided by Div. 26 (hired by BAS contractor) to BAS equipment.
- .4 Provide status function conduit and wiring for equipment covered under this Section.
- .5 Contractor shall provide conduit where wiring is exposed (e.g. mechanical & electrical rooms, penthouse, garage, etc.), otherwise FT-6 plenum rated wiring shall be used.
- .6 Provide conduit and wiring between the BAS panels and the temperature, humidity, or pressure sensing elements, including low voltage control wiring in conduit.
- .7 Provide conduit and control wiring for devices specified in this Section.

- .8 Provide conduit and signal wiring between motor starters in motor control centers and high and/or low temperature relay contacts and remote relays in BAS panels located in the vicinity of motor control centers.
- .9 Provide conduit and wiring between the PC workstation, electrical panels, metering instrumentation, indicating devices, miscellaneous alarm points, remotely operated contractors, and BAS panels, as shown on the drawings or as specified.
- .10 All wiring to be compliant to local building code and the NEC.
- .11 Provide electrical wall box and conduit sleeve for all wall mounted devices.

3.3 TEMPERATURE SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
 - .1 Protect from solar radiation and wind effects by stainless steel shields.
 - .2 Install in NEMA 12 enclosures.
- .4 Thermowells: install for piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.

3.4 TESTING AND COMMISSIONING

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

- END OF SECTION -

Part 1 - General

1.1 SUMMARY

- .1 Section Includes:
 - .1 At minimum provide detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
 - .1 Control Description Logic (CDL) for each system.
 - .2 Input/Output Point Summary Tables for each system.
 - .3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

1.2 SEQUENCING

- .1 Sequencing of operations for system as follows:
 - .1 Air Handling Unit AHU-1:
 - .1 BAS will control the system based on time of day schedule. During unoccupied period the system will be duty cycled in 100% recirculating mode to maintain unoccupied space temperature setpoint. Outdoor air dampers to be closed.
 - .2 When the unit is enabled to occupied mode, the sequence of operation is as follows:
 - .1 The fresh air damper, return air damper, chilled water cooling coil and hot water heating coil control valves to modulate in sequence to maintain space temperature setpoint. The fresh air and return air damper to modulate to maintain a maximum CO₂ level of 800 ppm (adjustable) as monitored by return air ductwork CO₂ sensor.
 - .2 Unit Status Report: The BAS shall provide an operating status summary of the following information to provide the operator with critical AHU operating data:
 - .1 Unit data.
 - .2 Operating mode.
 - .3 Active cooling/heating mode.
 - .4 Supply air temperature.
 - .5 Supply fan status.
 - .6 Heating & cooling valve position (modulation and feedback).
 - .7 Dirty filter.
 - .8 Mixed air temperature/discharge heating coil temperature/discharge unit temperature.
 - .9 Outside and return air damper position (modulation and feedback).
 - .10 CO₂ level.
 - .11 Supply air duct pressure.
 - .12 Outside air enthalpy.
 - .13 Return air enthalpy.
 - .3 Free cooling space temperature/humidity will be enabled/disabled using differential enthalpy sensors between return and outdoor air, when the cooling system has been disabled (below 10°C OA), free cooling shall also be enabled.
 - .4 Safety:
 - .1 The unit shall be c/w with freezestat on hydronic coil. Upon detection of water temperature below 5°C (adjustable) on a low return water temperature sensor on the hydronic heating coil de-energizes the system & announces critical alarm.
 - .2 A current switch is installed in the supply fan starter. The DDC system uses this switch to confirm the fan is in the desired state (i.e. on or off) and generates an alarm if status deviates from DDC start/stop control.
 - .3 A suction sensor & discharge sensor in AHU-1 will prevent over or under pressurization of system.
 - .2
 - .3
- .3 Radiant Panels:
 - .1 Hot water heating control valves to turn ON/OFF to maintain space temperature setpoint. When FC-1 is in cooling, hot water heating control valves shall be closed.

- .4 Ballroom Fan Coils:
 - .1 Provide DDC control valves to existing fan coils. Provide electronic-pneumatic transducers to connect to existing controls. Provide feedback to BAS to indicate if fan coil is in heating or cooling.
- .2 Make-up Air Unit (MUA):
 - .1 OA damper to be closed while unit is disabled. End switch to activate enable sequence.
 - .2 MUA to be enabled/disabled by BAS in sequence with operation of kitchen hood exhaust fan.
 - .3 MUA unit heating mode to be enabled/disabled by BAS based on OA temperature.
 - .4 MUA unit to modulate heating through internal controller to meet discharge air temperature setpoint. Discharge air temperature setpoint to be reset by BAS based on space temperature.
 - .5 MUA to send BAS dirty filter alarm and general alarm.
 - .6 BAS to control MUA VFD speed to track status of AHU OA damper position (during free cooling and optimized mode) and reset based on space pressure. Reference to CAFE. VFD speed minimum to be set on site and integrated limit into associated sequence.
- .3 Kitchen/Exhaust Fan/Demand Exhaust Controller:
 - .1 Kitchen exhaust fan to be enabled/disabled based on signal from packaged demand exhaust controller.
 - .2 BAS to monitor fan status and alarm condition at panel.
 - .3 Packaged demand exhaust controller to be ULC listed and factory calibrated with matching hood sensor to measure through infra-red technology the temperature profile on cooking surfaces below hood, compared against space temperature and activate kitchen exhaust fan, EF-1, within 30 seconds of cooling equipment turned on.
 - .4 Hood sensors to be installed within three (3) existing hoods in accordance with manufacturer's instructions. "ON" signal from any sensor will send enable signal to EF-1. Individual hold control and variable exhaust is not required.
- .4 Glycol Heating Loop:
 - .1 In heating mode, BAS to activate pump, P1, and monitor status.
 - .2 Three-way mixing valve to modulate based on AHU sequence to meet discharge air temperature setpoints.
 - .3 Two-way control valve on heating water side of HE-1 to modulate to maintain glycol supply temperature setpoint at 60°C.
 - .4 Glycol make-up tank to automatically maintain loop pressure at 83 kPa.
- .5 Optimized Mode:
 - .1 Optimized mode to be programmed as a user selectable sequence.
 - .2 The system (MUA and AHU) shall operate in heating mode in two stages. The first stage heating mode is referred to as optimized mode. Optimized mode is activated when the base building chilled water switch over loop is operating in heating mode. During optimized heating mode the AHU OA damper is prioritized to open, which in turn reduces MUA, VFD to minimum speed. Percent open position of OA damper to be determined on site during balancing. AHU temperature control will be provided by chilled water coil (operating as heating coil) as primary method of control. If chilled water valve is fully opened and temperature cannot be maintained, activate main heating coil to meet setpoint. If temperature still cannot be maintained activate stage two heating mode (normal operation - MUA VFD ramp up to full flow, AHU or damper modulate to closed position).
- .6 Dew Point Control Mode:
 - .1 During cooling season, continuously monitor AHU supply air temperature and compare against outdoor air dew point.
 - .2 If supply air temperature plus 3°C (adjustable based on site conditions) is below outside air dew point then modulate AHU OA damper open, MUA VFD speed down, and chilled water valve open to full. Modulate OA damper and VFD to maintain discharge air temperature setpoint.

Part 2 - Products

2.1 NOT USED

.1 Not Used.

Part 3 - Execution

3.1 NOT USED

.1 Not Used.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

1.2 REFERENCES

- .1 Definitions:
 - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .2 Reference Standards:
 - .1 CSA Group
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 Submit drawings and product data to authority having jurisdiction.
 - .6 If changes are required, notify NCC Representative of these changes before they are made.
- .4 Certificates:
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction for special approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to NCC Representative.
- .5 Manufacturer's Field Reports: submit to NCC Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for for incorporation into manual.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
 - .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
 - .4 Post instructions where directed.
 - .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
 - .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 - Products

2.1 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates and labels for control items in English and French.
- .4 Use one nameplate or label for each language.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment is are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.4 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates and labels as follows:
 - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, matt white finish face, black core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by NCC Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. [_____]" as directed by NCC Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.5 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.

- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.6 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	Auxiliary
up to 250 V	Yellow	
up to 600 V	Yellow	Green
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Other Security Systems	Red	Yellow

2.7 FINISHES

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
 - .1 Paint indoor switchgear and distribution enclosures light gray.

Part 3 - Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of NCC Representative.
 - .2 Inform NCC Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from NCC Representative.

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.3 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.
 - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1200 mm.
 - .2 Wall receptacles:
 - .1 General: 400 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1200 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 400 mm.
 - .5 Wall mounted telephone and interphone outlets: 1200 mm.
 - .6 Fire alarm stations: 1200 mm.
 - .7 Fire alarm bells: 2300 mm.
 - .8 Television outlets: 400 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
 - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
 - .3 Provide upon completion of work, load balance report as directed in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and

motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm.
 - .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of NCC Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 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 PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .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.

3.8 SYSTEM STARTUP

- .1 Instruct NCC Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.9 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

Part 1 - General

1.1 RELATED SECTIONS

- .1 Section 26 05 00 - Electrical General Requirements.

1.2 DEFINITIONS

- .1 SRS: acronym for Seismic Restraint System.

1.3 GENERAL DESCRIPTION

- .1 This section covers design, supply and installation of complete SRS for all systems, equipment specified for installation on this project by Division 26. This includes, but is not limited to, electrical light fixtures, transformers, MCC's, UPS, diesel generators, fire protection, conduit, communications, electrical equipment and systems, both vibration isolated and statically supported.
- .2 Cable restraint systems, rod stiffener clamps and seismic isolator capacities to be verified by an independent test laboratory. Connection materials and site specific designs to be by the Seismic Engineer. The Seismic Engineer may specify material and anchors provided by the contractor where this is appropriate. It is the contractors' responsibility to ensure that the Seismic Engineers' requirements and specification have been met.

1.4 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA S832-14, Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings.
- .2 National Research Council Canada
 - .1 NRCC NBCC-2010, National Building Code of Canada 2010.

1.5 SUBMITTALS

- .1 Submit shop drawings and product data in accordance with Section 26 05 00 - Electrical General Requirements.
- .2 Submit seismic restraint shop drawings, c/w seal of Professional Engineer registered in Province of Ontario, clearly identifying equipment/systems reviewed and the equipment/systems requiring restraint. Shop drawings must clearly show all forces transferred to structure.
- .3 Seismic Design Engineer shall provide a spreadsheet identifying all equipment and systems requiring or not requiring seismic restraints and include all circulations.
- .4 Submit additional copy of shop drawings and product data to project Structural Engineer for review of connection points to building structure.

1.6 MAINTENANCE DATA

- .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 26 05 00 - Electrical General Requirements.

1.7 SEISMIC FORCE

- .1 The Importance Factor for this project is:
 - .1 $I = 1.0$ - All other buildings i.e.: Office & General Buildings.

Note: As per NBCC.

Part 2 - Products

2.1 SRS MANUFACTURER

- .1 SRS to be from one manufacturer regularly engaged in production of same, 5 years experience.

2.2 GENERAL

- .1 Design to be by Professional Engineer specializing in design of SRS and registered in Province of Ontario. Division 26 to include all costs associated with this work as it relates to Division 26 installations.
- .2 SRS to be fully integrated into, compatible with:
 - .1 Noise and vibration controls specified elsewhere in this project specification, telecommunications.
 - .2 Structural, mechanical, electrical design of project.
- .3 During seismic event, SRS to prevent systems and equipment from causing personal injury, interfering with other systems, and from moving from normal position.
- .4 Design and installation in accordance with NBCC, CSA S832.
- .5 SRS to provide gentle and steady cushioning action and avoid high impact loads
- .6 SRS to restrain seismic forces in all directions.
- .7 Fasteners and attachment points to resist same load as seismic restraints.
- .8 SRS of conduit systems to be compatible with:
 - .1 Expansion, anchoring and guiding requirements.
 - .2 Equipment vibration isolation and equipment SRS.
- .9 SRS utilizing cast iron, threaded pipe, other brittle materials not permitted.
- .10 Attachments to RC structure:
 - .1 Use high strength mechanical expansion anchors.
 - .2 Drilled or power driven anchors not permitted.
- .11 Seismic control measures not to interfere with integrity of firestopping.

2.3 SRS FOR STATIC EQUIPMENT, SYSTEMS

- .1 Floor-mounted equipment, systems:
 - .1 Anchor equipment to equipment supports.
 - .2 Anchor equipment supports to structure.
 - .3 Use size of bolts scheduled in approved shop drawings.

- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Install tight to structure.
 - .2 Cross-brace in all directions.
 - .3 Brace back to structure.
 - .4 Slack cable restraint system.
 - .2 SRS to prevent sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
 - .3 Hanger rods to withstand compressive loading and buckling.

2.4 SRS FOR VIBRATION ISOLATED EQUIPMENT

- .1 Floor mounted equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Vibration isolators with built-in snubbers.
 - .2 Vibration isolators and separate snubbers.
 - .3 Built-up snubber system approved by NCC Representative, consisting of structural elements and elastomeric layer.
 - .2 SRS to resist complete isolator unloading.
 - .3 SRS not to jeopardize noise and vibration isolation systems. Provide 4-8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
 - .4 Cushioning action to be gentle and steady by utilizing elastomeric material or other means in order to avoid high impact loads.
- .2 Suspended equipment, systems:
 - .1 Use one or combination of following methods:
 - .1 Slack cable restraint system.
 - .2 Brace back to structure via vibration isolators and snubbers.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install Seismic Restraint Systems in accordance with Seismic Engineer's and manufacturer's recommendations.
- .2 Install SRS at least 25 mm from all other equipment, systems, services.
- .3 Co-ordinate connections with all disciplines.

3.2 INSPECTION AND CERTIFICATION

- .1 SRS to be inspected and certified by Manufacturer upon completion of installation.
- .2 Seismic Design Engineer shall provide written report to NCC Representative certifying that SRS has been installed in accordance with the SRS drawings. The report shall bear the seal and signature of the SRS Design Engineer.

3.3 COMMISSIONING DOCUMENTATION

- .1 Upon completion and acceptance of certification, hand over to NCC Representative complete set of construction documents, revised to show "as-built" conditions.

Part 1 - General

1.1 REFERENCES

- .1 CSA International
 - .1 CAN/CSA-C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No. 65-13, Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 National Electrical Manufacturers Association (NEMA)

Part 2 - Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No. 65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No. 65, with current carrying parts of copper sized to fit copper conductors 10 AWG or less.
- .3 Bushing stud connectors: to NEMA to consist of:
 - .1 Connector body and stud clamp for copper conductors.
 - .2 Clamp for copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as required.
- .4 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2 No. 18.

Part 3 - Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and cables and:
 - .1 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
 - .2 Install fixture type connectors and tighten to CAN/CSA-C22.2 No. 65. Replace insulating cap.
 - .3 Install bushing stud connectors in accordance with NEMA.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .3 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

Part 2 - Products

2.1 BUILDING WIRES

- .1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.
- .2 Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE.

2.2 ARMoured CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.
- .4 Connectors: anti short connectors.

Part 3 - Execution

3.1 GENERAL CABLE INSTALLATION

- .1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .3 Conductor length for parallel feeders to be identical.
- .4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .6 Branch circuit wiring to be 2-wire circuits only, i.e. common neutrals not permitted.

3.2 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

3.3 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible on channels.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

Part 2 - Products

2.1 EQUIPMENT

- .1 Grounding conductors: bare stranded copper, tinned, soft annealed, size as required.
- .2 Insulated grounding conductors: green, copper conductors, size as required.
- .3 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Pressure wire connectors.

Part 3 - Execution

3.1 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .7 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

3.2 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of NCC Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

Part 1 - General

1.1 NOT USED

- .1 Not used.

Part 2 - Products

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted or suspended.

Part 3 - Execution

3.1 INSTALLATION

- .1 Secure equipment to masonry, tile and plaster surfaces with lead anchors or nylon shields.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .6 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .7 For surface mounting of two or more conduits use channels at 1.5 m on centre spacing.
- .8 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .9 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .10 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .11 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of NCC Representative.
- .12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.

Part 2 - Products

2.1 SPLITTERS

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Construction:welded steel enclosure.
- .2 Covers Flush Mounted: 25 mm minimum extension all around.
- .3 Covers Surface Mounted: screw-on flat covers.

Part 3 - Execution

3.1 SPLITTER INSTALLATION

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
 - .2 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.
-

3.3 IDENTIFICATION

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name voltage and phase or as indicated.

Part 1 - General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-12, Canadian Electrical Code, Part 1 (22nd Edition), Safety Standard for Electrical Installations.

Part 2 - Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required.
- .3 Gang boxes where wiring devices are grouped.
- .4 Blank cover plates for boxes without wiring devices.
- .5 347 V outlet boxes for 347 V switching devices.
- .6 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 GALVANIZED STEEL OUTLET BOXES

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .4 Extension and plaster rings for flush mounting devices in finished plaster or tile walls.

2.3 CONDUIT BOXES

- .1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.4 FITTINGS - GENERAL

- .1 Bushing and connectors with nylon insulated throats.
 - .2 Knock-out fillers to prevent entry of debris.
 - .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
 - .4 Double locknuts and insulated bushings on sheet metal boxes.
-

Part 3 - Execution

3.1 INSTALLATION

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .5 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .6 Identify systems for outlet boxes as required.

Part 1 - General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .3 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
 - .4 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.

Part 2 - Products

2.1 CONDUITS

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings.
- .2 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

2.2 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1.5 m on centre.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.3 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.4 FISH CORD

- .1 Polypropylene.

Part 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 datasheets.

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms.
- .3 Use electrical metallic tubing (EMT) except in cast concrete.
- .4 Use flexible metal conduit for connection to motors in dry areas.
- .5 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .6 Minimum conduit size for lighting and power circuits: 19 mm.
- .7 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .8 Mechanically bend steel conduit over 19 mm diameter.
- .9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .10 Install fish cord in empty conduits.
- .11 Run 2-25 mm spare conduits up to ceiling space and 2-25 mm spare conduits down to ceiling space from each flush panel.
 - .1 Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of an exposed concrete slab, terminate each conduit in surface type box.
- .12 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .13 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on channels.
- .5 Do not pass conduits through structural members except as indicated.

- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No. 42-10, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CAN/CSA C22.2 No. 42.1-13, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
 - .3 CSA C22.2 No. 55-M1986(R2012), Special Use Switches.
 - .4 CSA C22.2 No. 111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

Part 2 - Products

2.1 SWITCHES

- .1 15, 20 A, 120 V, 347 V, single pole, double pole, three-way, four-way switches to: CSA C22.2 No. 55 and CSA C22.2 No. 111.
- .2 Manually-operated general purpose AC switches with following features:
 - .1 Terminal holes approved for No. 10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine moulding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle.
- .3 Switches of one manufacturer throughout project.

2.2 RECEPTACLES

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No. 42 with following features:
 - .1 White urea moulded housing.
 - .2 Suitable for No. 10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and rivetted grounding contacts.
- .2 Other receptacles with ampacity and voltage as indicated.
- .3 Receptacles of one manufacturer throughout project.

2.3 COVER PLATES

- .1 Cover plates for wiring devices to: CSA C22.2 No. 42.1.
 - .2 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.
 - .3 Stainless steel, 1 mm thick cover plates for wiring devices mounted in flush-mounted outlet box.
-

- .4 Sheet metal cover plates for wiring devices mounted in surface-mounted FS type conduit boxes.
- .5 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

2.4 SOURCE QUALITY CONTROL

- .1 Cover plates from one manufacturer throughout project.

Part 3 - Execution

3.1 INSTALLATION

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
 - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Receptacles:
 - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
 - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical as indicated.
 - .3 Install GFI type receptacles.
- .3 Cover plates:
 - .1 Install suitable common cover plates where wiring devices are grouped.
 - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .3 Repair damage to adjacent materials caused by wiring device installation.

Part 1 - General

1.1 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No. 5-13, Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2013).

PART 2 - PRODUCTS

2.1 BREAKERS GENERAL

- .1 Moulded-case circuit breakers: to CSA C22.2 No. 5
- .2 Bolt-on moulded case circuit breaker: quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
- .3 Common-trip breakers: with single handle for multi-pole applications.
- .4 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.

2.2 THERMAL MAGNETIC BREAKERS

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install circuit breakers as indicated.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No. 4-04(R2014), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No. 39-13, Fuseholder Assemblies.

Part 2 - Products

2.1 DISCONNECT SWITCHES

- .1 Fusible and non-fusible disconnect switch in CSA enclosure, to CAN/CSA-C22.2 No. 4 size as indicated.
- .2 Provision for padlocking in off switch position.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: to CSA C22.2 No. 39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-2002, Part 4: Electromechanical contactors and motor-starters.

Part 2 - Products

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 MANUAL MOTOR STARTERS

- .1 Single phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
 - .1 Switching mechanism, quick make and break.
 - .2 One overload heater, manual reset, trip indicating handle.
- .2 Accessories:
 - .1 Toggle switch: heavy duty labelled as indicated.
 - .2 Indicating light: heavy duty type and colour as indicated.
 - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.3 FULL VOLTAGE MAGNETIC STARTERS

- .1 Combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
- .3 Accessories:
 - .1 Pushbuttons Selector switches: heavy duty labelled as indicated.
 - .2 Indicating lights: heavy duty type and color as indicated.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.4 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

2.5 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.
- .3 Magnetic starter designation label, white plate, black letters, size 7 engraved as indicated.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.
- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

Part 1 - General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International).
- .2 Underwriters' Laboratories of Canada (ULC).

Part 2 - Products

2.1 LAMPS

- .1 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2 lumens, CRI 85; or as indicated.

2.2 BALLASTS

- .1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic.
 - .1 Rating: voltage as indicated, for use with 2-32W, rapid start lamps.
 - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
 - .3 Power factor: minimum 95% with 95% of rated lamp lumens.
 - .4 Current crest factor: 1.7 maximum.
 - .5 Harmonics: 10% maximum THD.
 - .6 Operating frequency of electronic ballast: 20 kHz minimum.
 - .7 Total circuit power: 62 Watts.
 - .8 Ballast factor: greater than 0.90.
 - .9 Sound rated: Class A.
 - .10 Mounting: integral with luminaire.

2.3 FINISHES

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

2.4 OPTICAL CONTROL DEVICES

- .1 As indicated in luminaire schedule.

2.5 LUMINAIRES

- .1 As indicated in luminaire schedule.

Part 3 - Execution

3.1 INSTALLATION

- .1 Locate and install luminaires as indicated.
- .2 Provide adequate support to suit ceiling system.

3.2 WIRING

- .1 Connect luminaires to lighting circuits:
 - .1 Install flexible or rigid conduit for luminaires as indicated.

3.3 LUMINAIRE SUPPORTS

- .1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 LUMINAIRE ALIGNMENT

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

Part 1 - General

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

1.2 REFERENCES

- .1 Treasury Board of Canada Secretariat (TBS), Occupational Safety and Health (OSH)
 - .1 Fire Protection Standard-10.
- .2 Underwriter's Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-14, Standard for the Installation of Fire Alarm Systems.
 - .2 CAN/ULC-S537-13, Standard for the Verification of Fire Alarm Systems.

Part 2 - Products

2.1 DESCRIPTION

- .1 Existing System is Simplex 4100U.
- .2 Regulatory Requirements:
 - .1 To TBS Fire Protection Standard.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.
 - .4 System components: listed by ULC and comply with applicable provisions of NBC, and meet requirements of local authority having jurisdiction.

Part 3 - Execution

3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 and TB Fire Protection Standard.
- .2 Locate and install detectors and connect to alarm circuit wiring. Mount detectors more than 1 m from air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.
- .3 Splices are not permitted.
- .4 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .5 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .6 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Test such device and alarm circuit to ensure, thermal and smoke detectors transmit alarm to control panel and actuate alarm.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.
 - .4 Addressable circuits system style DCLA:
 - .1 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open-circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
 - .2 Test each conductor on all DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
 - .5 Addressable circuits system style DCLB:
 - .1 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open-circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
 - .2 Test each conductor on all DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground-fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.
- .3 Provide final PROM program re-burn for system NCC Representative incorporating program changes made during construction.

3.3 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by fire alarm system installation.