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PROJECT

Interior Fit Up Phase Two
Regina, Saskatchewan

Volume Two

PROJECT No.	SET No.
30/2015	
DATE	
2017-02-03	

LIST OF DRAWINGS

ARCHITECTURAL

END OF SECTION

1 General

1.1 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)
  .1 ANSI/NFPA 13- 2013, Installation of Sprinkler Systems.

.2 Underwriters Laboratories of Canada (ULC)
  .1 ULC S543- 1984, Internal Lug Quick Connect Couplings for Fire Hose.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures and in accordance with ANSI/NFPA 13, working plans and design requirements.

.2 Sprinklers shall be referred to on drawings, submittals and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.3 ENGINEERING DESIGN CRITERIA

.1 Design system in accordance with ANSI/NFPA 13, using following parameters:
  .1 Hazard:
    .1 To suit occupancy as indicated.
  .2 Pipe size and layout:
    .1 Hydraulic design.
    .2 Sprinkler head layout: to ANSI/NFPA 13.
  .3 Water supply:
    .1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with ANSI/NFPA 13.Zoning:
      .1 System zoning as indicated.

1.4 CLOSEOUT SUBMITTALS

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

1.5 EXTRA MATERIALS

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

.2 Provide spare sprinklers and tools as required by ANSI/NFPA 13.

2 Products

2.1 PIPE, FITTINGS AND VALVES

.1 Pipe:
- .1 Ferrous: to ANSI/NFPA 13.
- .2 Copper tube: to ANSI/NFPA 13.

.2 Fittings and joints to ANSI/NFPA 13:
- .1 Ferrous: screwed, welded, flanged or roll grooved.
  - .1 Grooved joints shall consist of two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts.
    - .1 Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity. Couplings shall be fully installed at visual pad-to-pad offset contact. (Tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.) Victaulic Style 009-EZ, 005, and 07.
    - .2 Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for seismic applications. Victaulic Style 77.
- .2 Copper tube: screwed, soldered, brazed, or roll grooved.
  - .1 Grooved joints shall be manufactured to copper-tube dimensions, with housings cast with offsetting angle-pattern bolt pads. Victaulic Style 606.

.3 Valves:
- .1 ULC listed for fire protection service.
- .2 Up to NPS 2: bronze, screwed or grooved ends, OS & Y; gate or indicating ball valve. Victaulic Style 728.
- .3 NPS 2 1/2 and over: cast ductile iron, flanged or roll grooved ends, indicating butterfly valve. Victaulic Style 705W.
- .4 Swing or spring-actuated check valves. Victaulic Series 717.
- .5 Ball drip.

.4 Pipe hangers:
- .1 ULC listed for fire protection services.

2.2 SPRINKLER HEADS

.1 General: to ANSI/NFPA 13 and ULC listed for fire services.

.2 New sprinkler heads to match equivalent existing types. Confirm on site.

.3 Temperature rating on fusible links shall suit specific hazard area with minimum of safety 10 deg.C.

.4 Sprinklers shall be listed with and bear certification marking of nationally recognized testing agency.

.5 Sprinklers with O-rings are not allowed.

.6 Provide minimum 12 mm (1/2") nominal diameter discharge orifice, except when approved by authorities having jurisdiction.

.7 Provide chrome plated finish for sprinklers in all areas: except mechanical rooms where bronze finish is acceptable.

.8 All pendant type heads to be semi-recessed where possible.

.9 All sprinkler heads located in Mechanical Rooms and other areas susceptible to damage to be complete with wire guards.

.10 Sprinkler heads shall be located in the centre half or quarter point of ceiling tiles.

.11 Provide quick response heads in all light hazard areas.

.12 Sprinkler body shall be integrally cast with hex-shaped wrench boss to reduce the risk of damage during installations.

.1 Wrenches shall be provided by the sprinkler manufacturer that directly engage the hex-shaped wrench boss integrally cast in the sprinkler body.

2.3 PENDANT SPRINKLER HEAD

.1 Provide semi-recessed polished chrome glass bulb type in areas indicated on drawings or specified.

2.4 UPRIGHT SPRINKLER HEAD

.1 Provide polished chrome glass bulb type in areas indicated on drawings or specified. Bronze in mechanical rooms, chrome elsewhere.

2.5 SIDE WALL SPRINKLER HEAD

.1 Provide polished chrome glass bulb type in areas indicated on drawings or specified.

.2 Provide extended coverage where specified or required.

2.6 CONCEALED SPRINKLER HEAD

.1 Provide brass glass bulb type concealed sprinkler head with stainless steel deflector pins in areas indicated on drawings or specified.

.2 Unit to be complete with pre-assembled threaded adaptor that provides a minimum of ½" vertical adjustment with a matched low profile cover assembly.

.3 Cover plate finish to be selected by Architect for each ceiling type based on the following: Polished Chrome, Brushed Chrome, Bright Brass, Antique Brass, Brushed Brass, Brushed Copper, Painted White, Painted Ivory, or Painted Black.

2.7 DRY PENDANT SPRINKLER HEAD

.1 Provide polished chrome glass bulb type in areas indicated as preaction or non-freeze. For preaction systems utilized semi-recessed and for freezers utilize non-recessed with escutcheon.

2.8 DRY SIDEWALL SPRINKLER HEAD

.1 Provide polished chrome glass bulb type in areas indicated as preaction or non-freeze.

2.9 DOUBLE INTERLOCK PREACTION VALVE STATION

.1 Provide integrated fire protection system consisting of a preaction system trim totally pre-assembled, pre-wired and factory tested.

.2 All electrical and mechanical components of the system shall be contained in one single unit, rated for the intended application, and shall be complete with the standard trim including deluge valve, releasing control panel, releasing circuit disable switch, water supply control valve, preaction riser check valve, solenoid valve, pneumatic actuator, alarm pressure switch, low air supervisory switch, and options as noted within.

.3 Electric/pneumatic controlled, double interlock preaction systems to be complete with a pneumatic actuator, normally held closed by supervisory pressure maintained in the sprinkler system, a normally closed electric solenoid valve controlled by an approved system releasing control panel with compatible detection system.

.4 Both the electric detection system and supervisory pressure must be relieved from the sprinkler system before the deluge valve will open and fill the sprinkler system with water.

.5 Activation of a releasing device alone or operation of a sprinkler alone will sound an alarm but will NOT cause the system to fill with water.

.6 All the valves and trim shall be rated up to a maximum of 250 psi WWP (1724 kPa) max.

.7 cULus Listed & FM Approved as an assembled unit.

.8 Factory assembled and tested under ISO-9001 standards

.9 Prewired to an appropriate releasing control panel.

.10 Unit to be complete with the following galvanized trim piping, base mounting rail/platform, air connection coordinated with on site plant air, inlet & outlet hydrostatic test ports, and gauges to indicate air, water supply pressure and priming water pressure.

.11 Sequence of operation shall be: In a fire condition, when the detection system operates, system releasing control panel energizes solenoid valve open. Alarms activate, but the deluge valve will NOT open until a sprinkler opens relieving supervisory pressure from the sprinkler system. When a sprinkler opens, supervisory pressure in the sprinkler piping is reduced causing the pneumatic actuator to open. Pressure is released from the priming chamber of the deluge valve to the open drain manifold faster than it is supplied through the restricted orifice. The deluge valve clapper opens to allow water to flow into the

system piping and alarm devices, causing the alarm pressure switch and optional water motor alarm to activate. Water will flow from any open sprinklers and/or other opening in the sprinkler piping. When the deluge valve operates, the sensing end of the PORV is pressurized, causing the PORV to open. When the PORV opens, it drains the priming water pressure to the priming chamber, preventing the deluge valve from resetting, even if the open releasing devices close. The deluge valve can only be reset after the system is taken out of service, and the outlet chamber of the deluge valve and associated trim piping is depressurized and drained.

.12 Unit to be complete with shut-off valve and sight glass to permit testing without filling dry pipe to critical areas.

.13 Unit to be complete with an anti-column device to prevent an unwanted water column from establishing within the system riser

.14 Design is based on FireFlex Systems Inc. TotalPac 3 with Viking Trim including Viking VFR-400 releasing panel and due to space constraints without cabinet.

2.10 SIGNS

.1 Signs for control drain and test valves: to ANSI/NFPA 13.

2.11 SPARE PARTS CABINET

.1 Reuse existing cabinet.

.2 For storage of maintenance materials, spare sprinkler heads and special tools.

3 Execution

3.1 INSTALLATION

.1 Install, inspect and test to acceptance in accordance with ANSI/NFPA 13.

.2 Testing to be witnessed by Fire Commissioner of Canada and authority having jurisdiction.

.3 Install packaged preaction systems for areas indicated and connect to required services. Connect supervisory air to existing plant compressed air located in basement mechanical room.

3.2 INSPECTION

.1 Do not recess, paint or conceal piping accessories or work prior to inspection and approval by authorities having jurisdiction or authorized representative.

3.3 FIELD QUALITY CONTROL

.1 Subject systems and equipment to operational test.

.2 Hydrostatically test water supply connections and fire department connections at 345 mm in excess of normal working pressure but not less than 1400 kPa for 2 hours without loss under supervision.

.3 Upon complete installation of piping and apparatus for sprinkler systems, test joints for tightness and good condition of piping. When testing with water, install pressure gauge at highest point of installation. If impossible to test whole installation in single operation, subdivide into several zones and test each zone in manner described.

.4 During tests, stop any leaks and remove and repair any defective part. Perform test over again until satisfactory results are obtained.

.5 Provide hydraulic pump, temporary connections and labour required for tests.

3.4 ADJUSTMENT

.1 Adjust equipment to satisfaction of authorities having jurisdiction.

3.5 PROTECTION OF COMPLETE WORK

.1 Paint exposed steel pipe and fittings, except special finishes, in accordance with Division 9.

.2 Assume responsibility for protecting sprinkler heads during painting. Replace damaged and painted components.

.3 Provide red wire guards for sprinkler heads in mechanical and electrical rooms and around ventilation equipment, and all other areas required by Code or intended usage.

.4 Provide stainless steel guards for sprinkler heads in freezers.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Materials and installation for copper domestic water service used in the following:
  .1 Copper incoming domestic water service, up to NPS 2 1/2.
  .2 Hard drawn copper domestic hot and cold water services inside building.
  .3 Soft copper tubing inside building.
.2 Sustainable requirements for construction, verification and operation.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).
  .1 ANSI/ASME B16.15-02, Cast Bronze Threaded Fittings, Classes 125 and 250.
  .2 ANSI/ASME B16.18-01, Cast Copper Alloy Solder Joint Pressure Fittings.
  .3 ANSI/ASME B16.22-01, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  .4 ANSI/ASME B16.24-01, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.

.2 American Society for Testing and Materials International, (ASTM).
  .1 ASTM A307-03, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  .2 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube (Metric).
  .3 ASTM F492-95, Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.

.3 American Water Works Association (AWWA).
  .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).
  .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Department of Justice Canada (Jus).
  .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).

.6 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  .1 Material Safety Data Sheets (MSDS).

.7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
  .1 MSS-SP-67-02, Butterfly Valves.
  .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
  .3 MSS-SP-71-97, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
  .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.8 National Research Council (NRC)/Institute for Research in Construction.
  .1 NRCC 38728, National Plumbing Code of Canada (NPC) - 1995.

.9 Transport Canada (TC).
  .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

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 Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.

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 (no lead).

.4 Teflon tape: for threaded joints.

.5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM flush seal gasket.

.6 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.

2.4 GATE VALVES

.1 NPS 2 and under, soldered:
- .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 22 - Valves - Bronze.

.2 NPS 2 and under, screwed:
- .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 22 - Valves - Bronze.

2.5 SWING CHECK VALVES

.1 NPS 2 and under, soldered:
- .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 22 - Valves - Bronze.

.2 NPS 2 and under, screwed:
- .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 22 - Valves - Bronze.

2.6 BALL VALVES

.1 NPS 2 and under, screwed:
- .1 Class 150.
- .2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland and PTFE or BunaN seat, steel lever handle as specified Section 23 05 22 - Valves - Bronze.

.2 NPS 2 and under, soldered:
- .1 To ANSI/ASME B16.18, Class 150.
- .2 Bronze body, chrome plated brass ball, PTFE adjustable packing, brass gland and PTFE or BunaN seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 22 - Valves - Bronze.

3 Execution

3.1 INSTALLATION

.1 Install in accordance with Province Plumbing Code and local authority having jurisdiction.

.2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Install cold piping below and away from all hot piping so as to maintain temperature of cold water as low as possible.

.5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

3.2 VALVES

.1 Isolate equipment, fixtures and branches with ball valves.

3.3 PRESSURE TESTS

.1 Conform to requirements of Section 23 05 02 - General Mechanical Provisions.

.2 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.4 FLUSHING AND CLEANING

.1 Disinfect and rinse entire system to requirements of authority having jurisdiction and RCMP site standards.

.2 Flush entire system for 8 h. Ensure outlets flushed for 2 h. Let stand for 24 h, then draw one sample off longest run. Let system flush for an additional 2 hours, then draw a second sample (from same location). Submit to testing laboratory to verify system is clean to Federal potable water guidelines.

.3 Upon completion, provide laboratory test reports on water quality for Departmental Representative’s approval. Include one copy of approved test reports in Operation and Maintenance Manual.

3.5 START-UP

.1 Timing: Start up after:
- .1 Pressure tests have been completed.

.2 Provide continuous supervision during start-up.

.3 Start-up procedures:
- .1 Establish circulation and ensure that air is eliminated.
- .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
- .3 Monitor piping domestic hot piping systems for freedom of movement, pipe expansion as designed.
- .4 Check control, limit, safety devices for normal and safe operation.

.4 Rectify start-up deficiencies.

3.6 PERFORMANCE VERIFICATION

.1 Timing:
- .1 After pressure and leakage tests and disinfection completed, and certificate of completion has been issued by authority having jurisdiction.

.2 Procedures:
- .1 Verify that flow rate and pressure meet Design Criteria.
- .2 TAB in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
- .4 Sterilize domestic hot water systems for Legionella control.
- .5 Verify performance of temperature controls.
- .6 Verify compliance with safety and health requirements.
- .7 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
- .8 Confirm water quality consistent with supply standards, verifying that no residuals remain as a result of flushing and/or cleaning.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 The installation of drainage waste and vent piping. Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).
- .1 ASTM B32-03, Specification for Solder Metal.
- .2 ASTM B306-02, Specification for Copper Drainage Tube (DWV).
- .3 ASTM C564-03a, Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.2 Canadian Standards Association (CSA International).
- .1 CSA B67-1972(R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
- .2 CAN/CSA-B70-02, Cast Iron Soil Pipe, Fittings and Means of Joining.
- .3 CAN/CSA-B125-01, Plumbing Fittings.

2 Products

2.1 COPPER TUBE AND FITTINGS

.1 Above ground sanitary, storm and vent Type DWV to: ASTM B306.
- .1 Fittings.
  - .1 Cast brass: to CAN/CSA-B125.
  - .2 Wrought copper: to CAN/CSA-B125.
- .2 Solder: 95:5, type TA, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

.1 Buried sanitary, storm and vent minimum NPS 3, to: CAN/CSA-B70, with one layer of protective coating.
- .1 Joints.
  - .1 Mechanical joints.
    - .1 Neoprene or butyl rubber compression gaskets: to ASTM C564 or CAN/CSA-B70.
    - .2 Stainless steel clamps.
  - .2 Hub and spigot.
    - .1 Caulking lead: to CSA B67.
    - .2 Cold caulking compounds.

.2 Above ground sanitary, storm and vent: to CAN/CSA-B70.
- .1 Joints.
  - .1 Hub and spigot.
    - .1 Caulking lead: to CSA B67.

.2 Mechanical joints.
.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

3 Execution

3.1 INSTALLATION

.1 In accordance with Section 23 05 05 - Installation of Pipework.

.2 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.

3.2 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

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 that cleanout rods can probe as far as the next cleanout, at least.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:
.1 Verify domes are secure.
.2 Ensure weirs are correctly sized and installed correctly.
.3 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system and effectively vented.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 The installation of drainage waste and venting piping - plastic.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).
  .1 ASTM D2564-02, Specification for Solvent Cements for Poly (Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International).
  .1 CSA-Series B1800-02, Plastic Nonpressure Pipe Compendium.
  .2 CSA-B181.2-02, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
  .3 CSA-B182.1-02, Plastic Drain and Sewer Pipe and Pipe Fittings.

2 Products

2.1 PIPING AND FITTINGS

.1 For buried and or above ground DWV piping to:
  .1 CSA-B181.1.
  .2 CSA-B181.2.
  .3 CSA-B182.1.

2.2 JOINTS

.1 Solvent weld for PVC: to ASTM D2564.

3 Execution

3.1 INSTALLATION

.1 In accordance with Section 23 05 05 - Installation of Pipework.

.2 Install in accordance with Provincial Plumbing Code and local authority having jurisdiction.

3.2 TESTING

.1 Pressure test buried systems before backfilling.

.2 Hydraulically test to verify grades and freedom from obstructions.

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 Storm water drainage:
- .1 Verify domes are secure.
- .2 Ensure weirs are correctly sized and installed correctly.
- .3 Verify provisions for movement of roof system.

.4 Ensure fixtures are properly anchored, connected to system and effectively vented.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Materials and installation for plumbing specialties and accessories.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM).
- .1 ASTM A126-95 (2001), Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.

.2 Canadian Standards Association (CSA International).
- .1 CSA-B64 Series-01, Backflow Preventers and Vacuum Breakers.
- .2 CSA-B79-94 (R2000), Floor, Area and Shower Drains, and Cleanouts for Residential Construction.
- .3 CSA-B356-00, Water Pressure Reducing Valves for Domestic Water Supply Systems.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
- .1 Material Safety Data Sheets (MSDS).

.4 Plumbing and Drainage Institute (PDI).
- .1 PDI-G101-96, Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data.
- .2 PDI-WH201-92, Water Hammer Arresters Standard.

1.3 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 for fixtures and equipment.
- .2 Indicate dimensions, construction details and materials for specified items.

.3 Shop Drawings:
- .1 Submit shop drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions, construction and assembly details and accessories.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

.1 Health and Safety:
- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.2 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.3 Provide water and drainage connections to equipment furnished in other sections of this specification and by the Departmental Representative.

.4 Fittings of same type shall be product of one manufacturer.

2 Products

2.1 FLOOR DRAINS

.1 Floor Drains: to CSA B79.

.2 Provide trap primer tapping on all floor drains where trap primers are required by Code and authority having jurisdiction.

.3 FD-1 – Regular Floor Drain
- .1 Type 1 (General Duty): Epoxy coated cast iron body with double drainage flange, reversible clamping collar with primary and secondary weep holes, combined two piece body and adjustable nickel-bronze strainer. Shower and washroom floor drains shall have a removable perforated sediment bucket.
- .2 Type 2 (Heavy Duty): Epoxy coated cast iron body with double drainage flange, reversible clamping collar with primary and secondary weep holes, combined two piece body and adjustable heavy duty nickel-bronze strainer.
- .3 Type 3 (Combination Funnel Floor Drain): Epoxy coated cast iron body with double drainage flange, reversible clamping collar with primary and secondary weep holes, combined two piece body and adjustable nickel-bronze strainer with integral 102 mm x 229 mm oval nickel bronze funnel.

2.2 CLEANOUTS

.1 Cleanout: Adjustable floor cleanout with lacquered cast iron body and anchor flange, secondary O ring test seal, 4" diameter cleanout opening and combined scoriated satin finished nickel bronze cover and plug top assembly with stainless steel vandal-proof allan key screws and primary gasket seal. Provide membrane clamp for all membrane floors. Specification based on Mifab Model C1100.

.2 Access Covers:
- .1 Wall Access: face or wall type, polished nickel bronze with chrome plated cap, 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: round, nickel bronze, gasket, vandal-proof screws.
  - .3 Cover for Terrazzo Finish: Polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.
  - .4 Cover for Tile and Linoleum Floors: polished nickle bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.
  - .5 Cover for Carpeted Floors; polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal–proof locking screws.
- .3 Provide bolted cover plates on all vertical rainwater leaders.

2.3 WATER HAMMER ARRESTORS

.1 Stainless steel bellow type or copper piston type to PDIWH201.

.2 Air chamber same size as supply line or 19 mm minimum, and minimum 450 mm long.

2.4 TRAP SEAL PRIMERS

.1 Trap Seal Primer: Pressure drop activated brass trap seal primer, with inlet opening of 12 mm male NPT and outlet opening of female 12 mm NPT. Complete with four view holes and removable filter screen. Size to serve number of floor drains connected to primer. Primer shall require no adjustments and no air pre-charge. Specification based on Mifab Model M-500.

.2 Air Gap Fitting: Copper air gap fitting complete with a 12 mm male NPT fitting at the inlet supply incorporating a stream directing nozzle, a 12 mm NPT female outlet, and a ANSI/ASME A112.1.2 air gap in plumbing systems standard. Specification based on Mifab Model MI-GAP.

.3 Distribution Unit: Trap seal primer distribution unit with four brass compression outlet connections 12 mm, ABS body and HDPE lid with top 12 mm MIP connection, four 6 mm diameter vent holes in the flange and three 3 mm diameter Phillips head screws to secure the lid to the body. Unit complete with four wall internal body design that aligns with the slots in the underside of the lid to distribute water evenly and to only the desired number of ports. Specification based on Mifab Model M1-DU.

2.5 VACUUM BREAKERS

.1 Breakers: To CSA-B64 Series.

2.6 STRAINERS

.1 Size 50 mm and under: Screwed brass, Y pattern with 0.7 mm stainless steel perforated screen.

.2 Size 63 mm to 100 mm: Flanged iron body with bolted cap, Y pattern with 1.2 mm stainless steel perforated screen.

.3 Size 127 mm and larger: Flanged iron body, basket pattern with 3 mm stainless steel perforated screen.

.4 Screen free area shall be minimum three times area of inlet pipe. Provide valved drain and hose connection off strainer bottom.

2.7 LAUNDRY SERVICE BOX (Fire Rated LB-1)

.1 Fire Rated double outlet washing machine outlet box complete with ¼ turn brass ball valves with copper seat connections and 50mm PVC drain opening. Fire rating to meet or exceed fire rating on Architectural wall detail.

.2 Box to be bulk molded compound of thermoset fire-rated plastic.

.3 Unit to be complete with drain piece sleeve of galvanized steel with integrated intumescent pad.

.4 Unit to be complete with bulk molded compound thermoset fire-rated plastic plugs.

.5 Unit to be complete with PVC test cap.

.6 Unit to be complete with box fire rated pad, UL classified FyreWrap Insulation Material

.7 Unit to have adjustable mounting bracket to secure into stud wall.

.8 Unit to be complete with snap-on faceplate that accommodates up to two-layers of 5/8" drywall.

.9 Specification based on Oatey Fire Rated.

2.8 EMERGENCY SHOWER ES-1

.1 Existing combination emergency shower and eyewash to be relocated. Disconnect, protect and store until unit can be mounted in new location.

.2 Mount unit as per manufacturers requirements and connect to required services. Eyewash drain to be connected to sanitary.

2.9 EMERGENCY SHOWER ES-2

.1 Existing combination emergency shower and eyewash to be relocated. Disconnect, protect and store until unit can be mounted in new location.

.2 Mount unit as per manufacturers requirements and connect to required services. Eyewash drain to discharge to floor, provide elbow and piping to direct water to trench drain.

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 Install in accordance with Provincial Codes, and local authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

3.3 CLEANOUTS

.1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required by 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.

.4 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover remove cleanout plugs, relubricate and reinstall using only enough force to ensure permanent leak proof joint.

3.4 WATER HAMMER ARRESTORS

.1 Install on branch supplies to fixtures or group of fixtures as required to eliminate water hammer.

3.5 TRAP SEAL PRIMERS

.1 Install for floor drains and elsewhere, as required by Code and/or where indicated on drawings. Trap primers shall be electronic.

.2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Departmental Representative.

.3 Install plastic PEX tubing to floor drain.

3.6 STRAINERS

.1 Install with sufficient room to remove basket.

3.7 VACUUM BREAKERS

.1 Install vacuum breakers on plumbing lines where contamination of domestic water may occur; generally make-up lines, hose bibbs, and flush valves.

3.8 START-UP

.1 Timing: Start-up only after:
- .1 Pressure tests have been completed.
- .2 Disinfection procedures have been completed.
- .3 Certificate of static completion has been issued.
- .4 Water treatment systems operational.

.2 Provide continuous supervision during start-up.

3.9 TESTING AND ADJUSTING

.1 Timing:
- .1 After start-up deficiencies rectified.
- .2 After certificate of completion has been issued by authority having jurisdiction.

.2 Application tolerances:
- .1 Pressure at fixtures: within tolerance allowable by manufacturer.
- .2 Flow rate at fixtures: +/- 10%.

.3 Adjustments:
- .1 Verify that flow rate and pressure meet design criteria.
- .2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

.4 Floor drains:
- .1 Verify operation of trap seal primer.
- .2 Prime, using trap primer. Adjust flow rate and timer to suit site conditions.
- .3 Check operations of flushing features.
- .4 Check security, accessibility, removeability of strainer.
- .5 Clean out baskets.

.5 Vacuum breakers, backflow preventers, backwater valves:
- .1 Test tightness, accessibility for O&M of cover and of valve.
- .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
- .3 Verify visibility of discharge from open ports.

.6 Access doors:
- .1 Verify size and location relative to items to be accessed.

.7 Cleanouts:
- .1 Verify covers are gas-tight, secure, yet readily removable.

.8 Water hammer arrestors:
- .1 Verify proper installation of correct type of water hammer arrester.

.9 Strainers:
- .1 Clean out repeatedly until clear.
- .2 Verify accessibility of cleanout plug and basket.
- .3 Verify that cleanout plug does not leak.

.10 Hose bibbs, sediment faucets:
- .1 Verify operation of vacuum breakers.

.11 Training:
- .1 In accordance with Section 21 05 01 Common Work Results - Mechanical, Training of Operation and Maintenance Personnel, supplemented as specified.
- .2 Demonstrate full compliance with Design Criteria.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 The supply and installation of Plumbing Fixtures and Trim.

.2 Products Installed but not Supplied Under this Section:
- .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
- .2 Equipment installed by others.
  - .1 Connect with unions.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CAN/CSA-B45 Series-02, Plumbing Fixtures.
- .2 CAN/CSA-B125-01, Plumbing Fittings.
- .3 CAN/CSA-B651-95 (R2001), Barrier-Free Design.

1.3 SUBMITTALS

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

.2 Closeout Submittals:
- .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity, material, water consumption and details of all items noted under specification..
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

1.4 GENERAL REQUIREMENTS

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.

.4 Protect fixtures against use and damage during construction.

1.5 JOB CONDITIONS

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

2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.

.3 Exposed plumbing brass to be chrome plated.

.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.

2.2 WATER CLOSET WC-1 (Accessible Water Closet)

.1 Handicapped close coupled floor mounted 300 mm rough-in, tank style with 4.8 LPF (1.1 GPF) siphon jet flushing action. Water closet to be capable of flushing 1000 grams of waste under bulk waste removal protocols conducted by a CSA certified laboratory. Water closet to be complete with 5 year limited warranty.

.2 Bowl/Tank: 419 mm (16-1/2") high, white, vitreous china, elongated bowl, oversized flush valve, 54 mm (2-1/4") fully glazed trapway, siphon jet, 2 bolt caps, insulated tank complete with fittings and bolt down lid on tank.

.3 Supplies and Riser Tubes: chrome plated angle supplies with lockshield stem, screwdriver stop, 9.5 mm O.D. x 305 mm long flexible braided stainless steel riser and stainless steel escutcheon plate.

.4 Seat: White, elongated, open front, moulded plastic seat with cover and self-sustaining stainless steel hinges and stainless steel insert post.

.5 Design based on the following: Bowl/Tank - American Standard Cadet 3 FloWise Right Height Elongated, Seat - Bemis 1950SS, Supplies – Delta 47T2312SD

2.3 WATER CLOSET WC-2 (Standard Water Closet)

.1 Handicapped close coupled floor mounted 300 mm rough-in, tank style with 4.8 LPF (1.1 GPF) siphon jet flushing action. Water closet to be capable of flushing 1000 grams of waste under bulk waste removal protocols conducted by a CSA certified laboratory. Water closet to be complete with 5 year limited warranty.

.2 Bowl/Tank: 419 mm (16-1/2") high, white, vitreous china, elongated bowl, oversized flush valve, 54 mm (2-1/4") fully glazed trapway, siphon jet, 2 bolt caps, insulated tank complete with fittings and bolt down lid on tank.

.3 Supplies and Riser Tubes: chrome plated angle supplies with lockshield stem, screwdriver stop, 9.5 mm O.D. x 305 mm long flexible braided stainless steel riser and stainless steel escutcheon plate.

.4 Seat: White, elongated, open front, moulded plastic seat less cover and self-sustaining stainless steel hinges and stainless steel insert post.

.5 Design based on the following: Bowl/Tank - American Standard Cadet 3 FloWise Right Height Elongated, Seat - Bemis 1955SSC, Supplies – Delta 47T2312SD

2.4 WATER CLOSET WC-3 (Relocated Water Closet)

.1 Relocated existing water closet, prior to commencing work confirm water closet and all associated components being reused functions without defect and are whole and sound.

.2 Disconnect and remove existing water closet and store and protect until reinstallation.

.3 Install water closet in new location indicated and connect to required services.

.4 Recommission and confirm operation.

2.5 URINAL UR-1

.1 Wall hung siphon jet flush valve urinal 1.9 LPF (0.5 GPF). Urinal to be complete with 5 year limited warranty.

.2 Bowl: Vitreous china, top spud siphon-jet action with integral fully glazed trapway. Bowl to have anti-microbial surface equivalent to a double coated mirror finish. Nominal Dimensions: 356 mm (14") wide x 356 mm projection x 546 mm (21-1/2") high.

.3 Flush Valve: 1.9 litre exposed chrome plated automatic hard wire operated diaphragm style flush valve with recessed wall mounted infrared sensor, sensor range adjustment, true mechanical override button, dual filtered bypass, high back pressure vacuum breaker, adjustable tailpiece, bak-chek angle stop with vandal resistant cap and cast wall flange with setscrew. Provide 102mm square electrical box for mounting sensor plate and box mount hard wired transformer to convert 120V / 1 phase to 24 VA 50 A.

.4 Carrier, epoxy coated with heavy gauge steel uprights with welded feet supports and with top and bottom universal steel hanger plates with plated hardware, heavy gauge epoxy coated steel offset uprights, plated hardware. Each carrier to support one unit. Carrier to be suitable for installation in 102 mm (4") finished metal stud wall.

.5 Design based on the following: Bowl/Valve - Sloan WEUS-1005.1401-0.5 G2, Carrier – Watts CA-321.

3. Execution

3.1 INSTALLATION

.1 Install each fixture that is to be operational with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

.2 Provide chrome plated rigid or stainless steel flexible supplies to fixtures that are to be operational complete with screwdriver stops, reducers and escutcheons.

.3 Install wall mounted lavatories, urinals and water closets with approved wall carriers, model to suit installation.

.4 Mounting heights:

.1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified by architect.

.2 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.

.5 Install hose and faucets and hose connections with vacuum breakers.

3.2 PLUMBING FIXTURE ROUGH-IN SCHEDULE

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes or as required for particular fixtures:

	Hot Water	Cold Water	Waste	Vent
Water Closet (tank)	-----	12 mm (1/2")	75 mm (3")	51 mm (2")
Urinal (flush valve)	-----	19 mm (3/4")	51 mm (2")	38 mm (1-1/2")

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:
- .1 Adjust water flow rate to design flow rates.
- .2
- .3 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Checks:
- .1 Aerators or Laminar Flow Control: operation, cleanliness.
- .2 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:
- .1 Verify temperature settings, operation of control, limit and safety controls.

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 The supply and installation of Plumbing Fixtures and Trim.

.2 Products Installed but not Supplied Under this Section:
  .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
  .2 Equipment installed by others.
    .1 Connect with unions.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
  .1 CAN/CSA-B45 Series-02, Plumbing Fixtures.
  .2 CAN/CSA-B125-01, Plumbing Fittings.
  .3 CAN/CSA-B651-95(R2001), Barrier-Free Design.

1.3 SUBMITTALS

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

.2 Closeout Submittals:
  .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
  .2 Include:
    .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity, material, water consumption and details of all items noted under specification..
    .2 Details of operation, servicing, maintenance.
    .3 List of recommended spare parts.

1.4 GENERAL REQUIREMENTS

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.

.4 Protect fixtures against use and damage during construction.

1.5 JOB CONDITIONS

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

2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.

.3 Exposed plumbing brass to be chrome plated.

.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.

2.2 LAVATORY L-1 (Undercounter Manual)

.1 Bowl: oval undercounter lavatory, 546 mm x 441 mm, vitreous china, hole drilling to match trim, front overflow, glazed underside, white. Unit to be complete with mounting kit and template.

.2 Trim: ADA compliant chrome plated single lever manual faucet, 0.5 GPM/1.9 LPM vandal proof spray head, 100mm centerset, cast brass lead free waterway, ceramic dripfree disc valve cartridge, 89 mm lever.

.3 Supplies and Riser Tubes: chrome plated angle supplies with lockshield stem, screw-driver stop, 9.5 mm O.D. x 305 mm long flexible braided stainless steel riser and stainless steel escutcheon plate.

.4 Tailpiece and Trap: offset open grid drain assembly with open grid strainer. Chrome plated cast brass adjustable P-trap complete with cleanout, and escutcheon.

.5 Provide anti-scald temperature mixing controls: pressure independent thermostatic mixing valve complete with integral check valves, service isolation valves, and vandal resistant temperature setting adjustments.

.6 Insulate trap and supplies with Truebro Lavguard or equivalent accessibility approved pipe insulation assembly complete with PVC jackets for supplies tailpiece and trap assembly, white.

.7 Design based on the following: Bowl - American Standard Ovalyn Undercounter Sink, Trim – Delta 22C151, Supplies – Delta 47T2312SD, Tailpiece – Delta 33T290-1, Trap - Delta 33T311.

2.3 MOP SINK MS-1

.1 Bowl: 610 mm x 610 mm x 254 mm deep white moulded stone, floor mounted sink with 24 mm wide shoulders, SS strainer, complete with 76 mm brass drain assembly.

.2 Trim: Exposed wall type supply with cross handles, spout wall brace, vacuum breaker, plate, hose and bracket, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges, 760 mm of 12 mm diameter plain end reinforced hose, hose clamp and mop hanger.

.3 Provide check valves on hot and cold supply risers.

.4 Design based on the following: Bowl - Fiat MSB2424 with following accessories 830AA, 832AA, 889-CC.

3 Execution

3.1 INSTALLATION

.1 Install each fixture that is to be operational with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

.2 Provide chrome plated rigid or stainless steel flexible supplies to fixtures that are to be operational complete with screwdriver stops, reducers and escutcheons.

.3 Install wall mounted lavatories, urinals and water closets with approved wall carriers, model to suit installation.

.4 Mount fixtures above finished floor as noted on Architectural drawings.

.5 Install hose and faucets and hose connections with vacuum breakers.

.6 Mounting heights:
- .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified by architect.
- .2 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.

3.2 PLUMBING FIXTURE ROUGH-IN SCHEDULE

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes or as required for particular fixtures:

	Hot Water	Cold Water	Waste	Vent
Mop Sink	12 mm (½")	12 mm (½") (3")	75 mm (1-1/2")	38 mm
Lavatories	12 mm (1/2")	12 mm (1/2")	32 mm (1-1/4")	32 mm (1-1/4")

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:
- .1 Adjust water flow rate to design flow rates.
- .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Checks:
- .1 Aerators or laminar flow control: operation, cleanliness.
- .2 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:
- .1 Verify temperature settings, operation of control, limit and safety controls.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 The supply and installation of Plumbing Fixtures and Trim.

.2 Products Installed but not Supplied Under this Section:
- .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
- .2 Equipment installed by others.
  - .1 Connect with unions.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CAN/CSA-B45 Series-02, Plumbing Fixtures.
- .2 CAN/CSA-B125-01, Plumbing Fittings.
- .3 CAN/CSA-B651-95(R2001), Barrier-Free Design.

1.3 SUBMITTALS

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

.2 Closeout Submittals:
- .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity, material, water consumption and details of all items noted under specification..
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

1.4 GENERAL REQUIREMENTS

.1 Provide new fixtures, CSA approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be product of one manufacturer. Fittings of same type shall be product of one manufacturer.

.4 Protect fixtures against use and damage during construction.

1.5 JOB CONDITIONS

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

2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.

.3 Exposed plumbing brass to be chrome plated.

.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.

2.2 SHOWER SH-1 (Standard Shower)

.1 Cabinet: Refer to architectural.

.2 Trim: Concealed in-wall single lever pressure balancing mixing valve control, polished chrome plated metal trim, integral stops and checks, and vandal resistant metal lever handle; and adjustable stop screw to limit handle turn. Wall-mounted shower head with arm and flange, and polished chrome plated finish. Volume control - 7.6 LPM flow control. Unit to be vandal resistant. Trim to have 5-year warranty in commercial installation.

.3 Design based on: Trim - Symmons - Temptrol 96-1-2.0-X-CHKS-VP

3. Execution

3.1 INSTALLATION

.1 Install each fixture that is to be operational with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

.2 Provide chrome plated rigid or stainless steel flexible supplies to fixtures that are to be operational complete with screwdriver stops, reducers and escutcheons.

.3 Mounting heights:
- .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified by architect.
- .2 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.

3.2 PLUMBING FIXTURE ROUGH-IN SCHEDULE

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes or as required for particular fixtures:

	Hot Water	Cold Water	Waste	Vent
Shower	12 mm (½")	12 mm (½") (2")	50 mm (1-1/4")	38 mm

3.3 ADJUSTING

.1 Conform to water conservation requirements specified this section.

.2 Adjustments:
- .1 Adjust water flow rate to design flow rates.
- .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.3 Checks:
.1 Aerators or Laminar Flow Control: operation, cleanliness.
.2 Vacuum breakers, backflow preventers: operation under all conditions.

.4 Thermostatic controls:
.1 Verify temperature settings, operation of control, limit and safety controls.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 The Supply and Installation of Drinking Fountains and Water Coolers.
.2 Products Installed but not Supplied Under this Section:
  .1 Install rough-in for equipment supplied by others, complete with valves on hot and cold water supplies, waste and vent.
  .2 Equipment installed by others:
    .1 Connect with unions.
  .3 Equipment not installed.
    .1 Capped for future connection by others.

1.2 REFERENCES

.1 Air-Conditioning and Refrigeration Institute (ARI).
  .1 ARI 1010, Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.

.2 Canadian Standards Association (CSA International).
  .1 CAN/CSA-B45 Series, CSA Standards on Plumbing Fixtures.
  .2 CAN/CSA-B125, Plumbing Fittings.
  .3 CAN/CSA-B651, Barrier-Free Design.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.

.3 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
  .1 Indicate, for all fixtures:
    .1 Dimensions, construction details, roughing-in dimensions.
    .2 Sufficient technical data to check that equipment meets requirements of drawings and specifications.

.4 Closeout Submittals:
  .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

  .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.

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 Requirements.

2 Products

2.1 MANUFACTURED UNITS

.1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.

.2 Trim, fittings: manufacture in accordance with CAN/CSA-B125.

.3 Exposed plumbing brass to be chrome plated.

.4 Number, locations: Architectural drawings to govern.

.5 Drinking fountains:
- .1 DF-1 - Wall Mounted with bottle filler:
  - .1 Pressure drinking water cooler shall delivery a minimum of 30.3 lph of water at 10 deg.C cooled from 26.7 deg.C inlet water at 32.2 deg.C ambient. Single vandal resistant push button activation for bubbler. Built-in 100 micron strainer stops particles before they enter the waterway. Adjustable stream regulator shall control water flow between 20 and 120 psig. Stainless steel top shall have integral drain strainer. Water surfaces to have silver based or equivalent anti-microbial compound to reduce growth of micro-organisms and mildew.
  - .2 Bottle filler: Bottle filler with mechanical hands free activation and anti-microbial finish.
  - .3 Refrigeration System: Evaporator shall be high efficiency tank type and shall be encapsulated in insulation. R-134a refrigeration system shall be hermetically sealed and refrigerant flow shall be capillary tube controlled. An adjustable thermostat having an off position shall control refrigeration system.
  - .4 Finish: Unit to have stainless steel top and heavy-duty galvanized frame with sandstone powder coat paint and ADA compliant apron.
  - .5 Potable water system components shall comply with the Safe Drinking Water Act Amendments, the 1988 Lead Contamination Control Act and shall be Certified to NSF/ANSI 61, Section 9. Chilled water capacity shall be rated per ARI Standard 1010. Cooler shall be listed by Underwriters Laboratories Inc. to U.S. and Canadian safety standards. Drinking water cooler shall comply with ANSI A117.1 and ADA frontal approach and protruding object requirements.
  - .6 Electrical Requirements: 115V/60/1 phase, 4.5 FLA, 458 Watts, plug in type.
  - .7 Warranty: Limited five year warranty on sealed refrigeration system and most components.
  - .8 Basis of Design - Drinking fountain shall be an Oasis barrier-free vandal resistant Versa-Cooler II Model PGV8EBF with Versafiller bottle filler only (no equals or alternates).

.6 Fixture piping:
.1 Cold water supplies to each fixture:
.1 Chrome plated rigid supply pipes each with screwdriver stop, reducers, escutcheon unless noted otherwise.
.2 Waste:
.1 Brass P trap with cleanout on each fixture not having integral trap.
.2 Chrome plated in all exposed places.

.7 Chair carriers:
.1 Factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.

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, measured from finished floor.
.3 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.

.2 Drinking fountains and water coolers:
.1 In accordance with ARI 1010.

3.2 ADJUSTING

.1 Conform to water conservation requirements specified this Section.

.2 Adjustments:
.1 Adjust water flow rate to design flow rates.

.2 Adjust water cooler, drinking fountain flow stream to ensure no spillage.

.3 Checks.
.1 Refrigerated water coolers: operation, temperature settings.

.4 Thermostatic controls.
.1 Verify temperature settings, operation of control, limit and safety controls.

END OF SECTION

Part 1 - General

1.1 RELATED WORK

.1	Fire Extinguishers	Division 10
.2	Fire Suppression	Division 21
.3	Plumbing	Division 22
.4	Heating, Ventilating and Air Conditioning	Division 23
.5	Integrated Automation	Division 25

1.2 INTENT

.1 Provide a complete and fully operational mechanical system with facilities and services to meet requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract documents of for mechanical scope are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Should any discrepancies occur on drawings or in specifications which leaves doubt as to the intent and meaning of the drawings and specifications, obtain a ruling from the designer before submitting tender. If this is not done, it will be assumed that the most expensive alternate has been allowed for.

.4 Follow manufacturer's recommended installation details and procedures for equipment supplemented by details given herein and on plans subject to approval of the Departmental Representative.

.5 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Departmental Representative at no extra cost.

.6 Provide labour and materials required to install, test and place into operation complete mechanical system. Provide additional material for modifications required to correct minor job conflictions.

.7 Connect to equipment furnished in other Sections and by Departmental Representative, including uncrating equipment, moving in place and installing complete, start-up and test.

3. MATERIALS

.1 Replace materials or workmanship below specified quality and relocate work wrongly placed to satisfaction of the Departmental Representative.

.2 Materials and equipment installed shall be new, full weight and of the best quality specified. Use same brand or manufacturer for each specific application. Statically and dynamically balance rotating equipment for minimum vibration and low operating noise level.

.3 Each major component of equipment shall have manufacturer's name, address, catalog and serial number in a conspicuous place.

.4 Install materials and equipment in a neat and workmanlike manner by competent specialists.

4. CUTTING AND PATCHING

.1 Locate and provide holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves at no extra cost.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Do no cutting or burning of structural members of building frame without obtaining prior written approval from the Departmental Representative.

.4 Provide openings and holes required in precast members for mechanical work. Cast holes larger than 100 mm (4") in diameter. Field-cut smaller than 100 mm (4").

.5 All patching of finished construction of building shall be performed under the sections of specifications covering these materials.

5. SEMI-FINAL AND FINAL INSPECTIONS

.1 Perform the following items prior to semi-final inspection.

- .1 Heating and air conditioning systems capable of operation with alarm controls functional and automatic controls in operation generally, but not necessarily finally calibrated.
- .2 Necessary tests on equipment made including those required by authorities and certificates of approval obtained.
- .3 Rough balance of air and water systems completed.
- .4 Valve tagging completed and equipment identified. Equipment and piping painted and escutcheons installed.
- .5 Equipment lubricated as per manufacturer's data.
- .6 Warranty forms have been mailed to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one year.
- .7 Systems chemically cleaned, flushed and water treatment initiated. Provide report from manufacturer's representative to confirm status of treatment.
- .8 Submit sample of Operating/Maintenance Manuals. Arrange Operating and Maintenance Instructions and submit schedule for approval.
- .9 Review and ensure access doors are suitably located and equipment easily accessible including plumbing cleanouts.
- .10 Have noise and vibration control devices and flexible connections inspected by manufacturer's representative and submit written report.
- .11 Equipment alignment carried out by qualified millwright and certified report submitted.
- .12 Check operations of plumbing systems and fixtures and ensure fixtures are solidly supported.
- .13 Fan plenums cleaned, temporary filters removed and permanent filters installed.

.2 Provide declaration in writing that semi-final deficiencies and the following items have been completed prior to the final inspection:

- .1 Equipment cleaned inside, outside and lubricated. Plumbing fixtures and brass cleaned.
- .2 Final balancing completed and rough data of balance reports submitted.
- .3 Final calibration of controls completed.

6. SHOP DRAWINGS

.1 Refer to Division 1.

.2 Submit materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalog material. Do not assume applicable catalogues are available in the Departmental Representative's office. Maintenance and operating manuals are not suitable submittal material.

.3 Clearly mark each sheet of printed submittal material (using arrows, underlining or circling) to show particular sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pump seals, materials or painting.

.4 Include dimensional data for roughing in and installation, technical data sufficient to check that equipment meets requirements of drawings and specifications, wiring, piping, and service connection data, motor sizes complete with voltage ratings and schedules as applicable.

7. OPERATING AND MAINTENANCE MANUALS

.1 Provide services of qualified and experienced personnel to prepare proper documentation and to instruct the Operating Staff in the operation and preventative maintenance of each piece of equipment and system supplied and installed. Complete and turn over documentation prior to final inspection.

.2 Provide 215 mm x 280 mm (8-1/2" x 11") capacity extension type catalogue binders bound with heavy fabric, hot stamped in gold lettering front and spine. Refer to Division 1 for colour and quantity.

.3 Each binder shall be indexed according to the following indexing system:

.4 Tab-1.0 Mechanical Systems: Title page with clear plastic protection cover.

.5 Tab-1.1 List of Mechanical Drawings.

.6 Tab-1.2 Description of Systems: Provide complete description of each system. Include detailed system description and components comprising that system, explanation of how each component interfaces with others to complete the system, location of each thermostat, controller or operating setpoints. Refer to 21 0-5 01, 1.1.5 for additional required information.

.7 Tab-1.3 Operation Division: Provide complete and detailed operation of each major component. Include how to energize and exact location of switches and controls, how the component interfaces with other components, operation of controls, including the operational sequence, operational characteristic changes for summer or winter operation, and how to accomplish the changeover, complete troubleshooting sequence, setpoints cannot be maintained, and safeguards to check if equipment goes off line. Refer to 21 0-5 01, 1.1.5 for additional required information.

.8 Tab-1.4 Maintenance and Lubrication Division: Provide detailed preventative maintenance and lubrication schedule for each of the major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain how to proceed

with each task required for each piece of typical equipment such as bearings, drives, motors and filters. Compile this information for each typical piece of equipment separate from the shop drawings section. Refer to 21 0-5 01, 1.1.5 for additional required information.

.9 Tab-1.5 List of Equipment Suppliers and Contractors: Provide complete list of equipment suppliers and contractors, including address and telephone number. Outline procedures for purchasing parts and equipment. Include steps to take in order to purchase new parts.

.10 Tab-Certification (2.0, 2.1, etc.): Include copy of test data degreasing and flushing of heating system analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, hot air heating and ventilation systems and fire damper schedule.

.11 Tab-Shop Drawings and Maintenance Bulletins (3.0, 3.1, etc.): Provide materials as received in compliance with clause "Shop Drawings".

.12 The divider tabs shall be laminated mylar plastic, and coloured according to section. The colouring is as follows: Mechanical Systems - 1.0 - 1.5 - Orange, Certification - 2.0 - 2.4 - Green, Shop Drawings and Maintenance - 3.0 - 3.17 - Yellow. Plastic tabs with typed insertions will not be accepted.

.13 Submit documents to the Departmental Representative for approval prior to being turned over to the Departmental Representative. At completion of project, hold a Seminar to instruct the Operating Staff in operation and preventative maintenance of each piece of equipment and system supplied and installed.

.14 Provide one digital copy on compact disk of the final operation and maintenance manual in each of the manuals (six in total).

8. RECORD DRAWINGS

.1 Refer to Division 1.

.2 Site records:

- .1 Departmental Representative will provide one (1) set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
- .2 Record drawings shall identify location of fire dampers, major control lines, access doors, tagged valves and actual room names or numbers.
- .3 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
- .4 Use different colour waterproof ink for each service.
- .5 Make available for reference purposes and inspection.

.3 As-built drawings:

- .1 Prior to start of Testing, Adjusting and Balancing for HVAC, 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 to Departmental Representative for approval and make corrections as directed.
.4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
.5 Submit completed as-built drawings with Operating and Maintenance Manuals.

9. IDENTIFICATION

.1 Refer to Section 23 05 54, Mechanical Identification.

10. TEMPORARY FACILITIES

.1 Refer to General Requirements - Division 01.

11. SUPERVISION

.1 Refer to General Requirements - Division 01.

12. EQUIPMENT PROTECTION AND CLEAN-UP

.1 Protect equipment and materials in storage on site, during and after installation until final acceptance. Leave factory covers in place and take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not re-use existing materials and equipment unless specifically indicated.

13. TEMPORARY OR TRIAL USAGE

.1 Temporary or trial usage by the Departmental Representative of mechanical equipment supplied under contract and claimed complete before final acceptance shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

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

14. WASTE MANAGEMENT AND DISPOSAL

.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.
- .3 Store and manage hazardous materials in accordance with cepa, tdga AND Regional and Municipal Regulations.

.2 Waste Management and Disposal:
- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 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.
- .3 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .4 Unused sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .5 Fold up metal and plastic banding, flatten and place in designated area for recycling.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.
- .7 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial, Territorial and Municipal regulations. Dispose of asbestos waste in sealed double thickness 6 ml bags or leak proof drums. Label containers with appropriate warning labels.
- .8 Provide manifests describing and listing waste created. Transport containers by approved means to licenced landfill for burial.

15. DEMOLITION

.1 Mechanical Contractor shall include in his Base Price the cost to provide the removal of all existing mechanical equipment and material that is not to be reused under this contract. Equipment shall be Departmental Representatives' salvage unless noted otherwise.

16. INSTRUCTION OF OPERATING STAFF

.1 Provide trained personnel to instruct operating staff on maintenance, adjustment and operation of mechanical equipment. Instruct staff on changes or modification in equipment made under terms of guarantee.

.2 Provide instruction during regular work hours prior to acceptance and turnover to operating staff for regular operation.

.3 Use operation and maintenance data manual for instruction purposes. On completion of instruction, turn one manual over to chief operating personnel, the balance to Departmental Representative.

.4 Record every instruction and training session on digital video.

.5 Time allocated for Instruction:

Fire Protection	One (1) hour instruction
Controls	Total training to be 10 hours of instruction.
Exhaust Fans	One (1) hour instruction

17. SUBSTANTIAL COMPLETION

.1 The mechanical portion of the project shall be deemed substantially complete when ALL mechanical systems are operational as designed. In addition, the air and/or water balance must be completed with the report submitted and approved by the Departmental Representative and the temperature control system must be complete, as designed, operational, with all control components calibrated and the maintenance manuals in final form must be submitted. The date will be established by the Departmental Representative and will set the date for the start of the one (1) year warranty on all mechanical systems.

18. EXCESSIVE ADMINISTRATION

.1 Following the "Substantial Completion" Inspection a "Final" Inspection will be conducted and a follow up inspection will be conducted to "check off" all outstanding mechanical deficiencies.

.2 If the mechanical portion of the project is not 100 percent completed at that time the cost of all additional inspections will be back-charged to the Mechanical Contractor.

.3 The cost of each inspection will be $750.00 plus travel, and will be deducted from the total Mechanical Contract amount.

.4 The frequency of the additional inspections will be determined by the Departmental Representative.

19. ALTERNATE AND SEPARATE PRICES

.1 Referenced specification sections and drawings contain pertinent requirements for materials and methods to achieve work described herein.

.2 Coordinate pertinent related work and modify surrounding work as required to complete project under each alternate designated.

.3 Alternate products may vary in operation or construction, but shall meet or exceed the requirements of the specifications, drawings and the specified equipment for performance capacities, controllability and equipment options.

.4 Revisions required to adapt equipment other than that specified shall be made without extra charge to the Departmental Representative.

20. ALTERNATE MATERIALS & EQUIPMENT

.1 This contract shall be based on materials and equipment as specified.

.2 Make proposals to supply alternate materials or equipment in writing to the Departmental Representative at least ten days prior to closing date of tender for Mechanical Trade.

.3 All proposed equipment is subject to the requirements of the drawings and specifications. Revisions required to adapt equipment other than that specified shall be made without extra charge to the contract. All suppliers, except those specified, shall guarantee in writing that their individual proposed products meet or exceed the performance and quality of specified products.

.4 The following products shall be supplied as specified, there is no equal product that will be accepted:
.1 EMCS: shall be expansion of existing Honeywell Controls.

Part 2 - Materials

2.1 NOT USED

.1 Not Used

Part 3 - Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

1 General

1.1 REFERENCES

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

2 Products

2.1 PIPE

	Service	Material
.1	Hot water heating (to 110 deg.C)	Steel Schedule 40, black, 9.5 mm wall for sizes 300 mm and larger, Grooved for 50 mm and larger.
.2	Equipment drains and overflows	Steel Schedule 40, galvanized, PVC
.3	Sanitary drainage and vent above grade	Type “M” or “DWV” copper, cast iron, plastic PVC-XFR-15/50, CPVC
.4	Domestic water unburied	Type "L" hard copper, PEX.
.5	Fire protection	Lightwall pipe, as approved by NFPA, Schedule 30 or to match existing.

2.2 FITTINGS

	Service	Material	Joint
.1	Hot water heater to 110 deg.C	Malleable iron 1034 kPa	Threaded banded Grooved mechanical
		Steel same thickness as pipe Wrought copper or cast bronze	Pressfit fittings
.2	Vents	Malleable iron 1034 kPa banded	Threaded
.3	Equipment drains	Malleable iron 1034 kPa banded, galvanized. Steel, same thickness as pipe, galvanized. Malleable iron, grooved galvanized. Wrought copper or cast brass. PVC	Threaded Welded Grooved mechanical 95-5 solder, grooved mechanical Solvent weld or grooved mechanical

.4	Sanitary drainage and Vent unburied	Wrought copper or cast iron	95-5 solder Hub & Spigot
		Solvent weld or	PVC-XFR-15/50, CPVC grooved mechanical
.5	Domestic water inside building	Wrought copper bronze	95-5 solder, or cast brass grooved mechanical
		PEX	Mechanical joint
.6	Fire protection	Malleable iron or cast iron Malleable iron or steel grooved Steel, same thickness as pipe	Screwed or flanged Grooved mechanical
.7	Storm	Cast iron	Hub & Spigot Gasket & Clamp
		PVC	Solvent weld, or grooved mechanical

.8 Use factory fabricated butt welded fittings for welded steel pipes.

.9 Use long radius elbows for steel and cast iron water piping.

3 Execution

3.1 CONNECTIONS TO EQUIPMENT

.1 In accordance with manufacturer's instructions unless otherwise indicated.

.2 Use valves and unions or flanges (as indicated) 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.

3.2 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 or as indicated (whichever is greater) without interrupting operation of other system, equipment, components.

3.3 DRAINS

.1 Install piping with grade in direction of flow except as indicated.

.2 Install drain valve complete with isolation at low points in piping systems, at equipment and at section isolating valves.

.3 Pipe each drain valve discharge separately to nearest floor drain where indicated. 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.

3.4 AIR VENTS

.1 Install manual air vents at high points in piping systems complete with isolation valve and u-bend copper tubing to allow discharge to bucket.

.2 Install automatic air valve at each air separator and where indicated.

.3 Install isolating valve at each automatic air valve.

.4 Install drain piping to approved location and terminate where discharge is visible.

3.5 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.

3.6 ROUTE AND GRADES

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furrings to a minimum.

.2 Slope water piping 25 mm in 12 m and arrange to drain at low points.

.3 On closed systems, equip low points with 20 mm drain valves and hose nipples. Provide, at high points, collecting chambers and high capacity float operated automatic air vents.

.4 Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.

.5 Grade horizontal drainage and vent piping 20 mm per meter minimum.

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 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main.
- .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .2 Do not project branch pipe inside the main pipe.

.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 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.11 Group piping wherever possible.

.12 Ream pipes, remove scale, welding slag and other foreign material, inside and outside before assembly.

.13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.14 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.15 Screw joint steel piping up to and including 38 mm . Weld piping 63 mm and larger, including branch connections. Screw or weld 50 mm piping.

.16 Make screwed joints with full cut standard taper pipe threads with red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

.17 Clamp cast iron water pipe at fittings with 20 mm rods and properly anchor and support.

.18 Use grooved mechanical couplings and mechanical fasteners in accessible locations, risers, pipe chases, and in other locations as approved by Departmental Representative. Use flexible couplings at pumps, coils and all vibration isolated equipment in lieu of flexible connectors, all other couplings to be rigid.
- .1 Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions.
- .2 The grooved coupling manufacturer's factory trained representative shall provide on-site training for Contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the job site and review Contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or job site visits.)

.19 Make connections to equipment and branch mains with unions or flanges, as indicated:
- .1 Unions are not required in installations using grooved mechanical joint couplings (The couplings shall serve as disconnect points.)

.20 Provide non-conducting type connections wherever jointing dissimilar metals in systems. Brass adaptors and valves are acceptable. Refer to dielectric couplings.

.21 Pressfit piping and fittings are not permitted.

.22 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.1 For mechanical pipe jointing systems, use adequate numbers of Victaulic Style 77 flexible couplings in header piping to accommodate thermal growth and contraction, and for the elimination of expansion loops. (In accordance with Victaulic instructions and as approved by the Departmental Representative.) Where expansion loops are required, use Victualic Style 77 couplings on the loops.

.23 Install piping material specified as inside the building to 2.4 meters outside of building.

.24 Use of PVC plastic pipe allowed where approved by the authority having jurisdiction. PVC pipe run in plenum spaces shall have flame and smoke rating for that purpose. PVC pipe to be complete with ULC labelled fire stopping wherever penetrating fire separations.

.25 Valves:

.1 Install in accessible locations.
.2 Remove interior parts before soldering.
.3 Install with stems upright or horizontal, not inverted.
.4 Valves accessible for maintenance without removing adjacent piping.
.5 Install globe valves in bypass around control valves.
.6 Use ball valves up to 50 mm or butterfly valves 63 mm and larger at branch take-offs for isolating purposes except where otherwise specified.
.7 Install butterfly valves between weld neck flanges to ensure full compression of liner.
.8 Install ball valves for glycol service and domestic water.
.9 Install gate, ball and butterfly valves for isolating service, to isolate equipment, part of systems or vertical risers.
.10 Install globe, ball or angle valves for throttling service.
.11 Use plug cocks in water systems for throttling service. Use non-lubricated plug cocks only when shut-off or isolation valves are also provided.
.12 Use butterfly valves in fire protection systems where approved.
.13 Provide drain valves at main shut-off valves, low points of piping and apparatus.

.26 Provide thermometers, thermometer wells, and DDC sensor wells where thermometers are indicated on drawings and schematics.

.27 Provide plug cocks at all pressure tapping locations.

3.8 SLEEVES

.1 General: Install where pipes pass through masonry, concrete structures, fire rated assemblies, and elsewhere as indicated.

.2 Material: Schedule 40 black steel pipe.

.3 Construction: Foundation walls and where sleeves extend above finished floors to have annular fins continuously welded on at mid-point.

.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: Provide space for firestopping. 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. Chrome or nickel plated brass or type 302 stainless steel.

.3 Sizes: Outside diameter to cover opening or sleeve. Inside diameter to fit around pipe or outside of insulation if so provided.

3.10 PREPARATION FOR FIRESTOPPING

.1 Material and installation within annular space between pipes, ducts, insulation and adjacent fire separation to Section 07 84 00 - Firestopping.

.2 Uninsulated unheated pipes not subject to movement: No special preparation.

.3 Uninsulated heated pipes subject to movement: Wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.

.4 Insulated pipes and ducts: Ensure integrity of insulation and vapour barriers.

3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 In accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11-Cleaning supplemented as specified in relevant sections of Mechanical.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: Test as specified in relevant sections of Mechanical or to 1.5 times maximum operating pressure. All installed piping to be tested unless noted otherwise.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant sections of Mechanical.

.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 Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.

.7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.13 EXISTING SYSTEMS

.1 Connect into existing piping systems at times approved by Departmental Representative.

.2 Request written approval 10 days minimum, prior to commencement of work.

.3 Be responsible for damage to existing plant by this work.

.4 Ensure daily clean-up of existing areas.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Bronze - valves.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ American Society of Mechanical Engineers (ASME).
  .1 ANSI/ASME B1.20.1-1983(R2001), Pipe Threads, General Purpose (Inch).
  .2 ANSI/ASME B16.18-2001, Cast Copper Alloy Solder Joint Pressure Fittings.

.2 American Society for Testing and Materials International, (ASTM).
  .1 ASTM A276-04, Specification for Stainless Steel Bars and Shapes.
  .2 ASTM B62-02, Specification for Composition Bronze or Ounce Metal Castings.
  .3 ASTM B283-99a, Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
  .4 ASTM B505/B505M-02, Specification for Copper-Base Alloy Continuous Castings.

.3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  .1 MSS-SP-25-1998, Standard Marking System for Valves, Fittings, Flanges and Unions.
  .2 MSS-SP-80-2003, Bronze Gate Globe, Angle and Check Valves.
  .3 MSS-SP-110-1996, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.
  .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submittal Procedures.
  .2 Submit data for valves specified in this section.

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

2 Products

2.1 MATERIALS

.1 Valves:
  .1 Except for specialty valves, to be single manufacturer.
  .2 All products to have CRN registration numbers.

.2 End Connections:
.1 Connection into adjacent piping/tubing:
.1 Steel pipe systems: Screwed ends to ANSI/ASME B1.20.1.
.2 Copper tube systems: Solder ends to ANSI/ASME B16.18.
.3 Provide flanged ends as indicated under 23 05 01, Installation of Pipework.

.3 Lockshield Keys:
.1 Where lockshield valves are specified, provide 10 keys of each size: malleable iron cadmium plated.

.4 Gate Valves:
.1 Requirements common to gate valves, unless specified otherwise:
.1 Standard specification: MSS SP-80.
.2 Bonnet: union with hexagonal shoulders.
.3 Connections: screwed with hexagonal shoulders.
.4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
.5 Packing: non-asbestos.
.6 Handwheel: non-ferrous.
.7 Handwheel Nut: bronze to ASTM B62.
.2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
.1 Body: with long disc guides, screwed bonnet with stem retaining nut.
.2 Operator: Handwheel.
.3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
.1 Body: with long disc guides, screwed bonnet with stem retaining nut.
.2 Operator: Handwheel.
.4 NPS 2 and under, rising stem, split wedge disc, Class 125:
.1 Body: with long disc guides, screwed bonnet.
.2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
.3 Operator: Handwheel.
.5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
.1 Body: with long disc guides, screwed bonnet.
.2 Operator: Handwheel.
.6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
.1 Body: with long disc guides, screwed bonnet.
.2 Operator: Handwheel.

.5 Globe Valves:
.1 Requirements common to globe valves, unless specified otherwise:
.1 Standard specification: MSS SP-80.
.2 Bonnet: union with hexagonal shoulders.
.3 Connections: screwed with hexagonal shoulders.
.4 Pressure testing: to MSS SP-80. Tests to be hydrostatic.
.5 Stuffing box: threaded to bonnet with gland follower, packing nut, high grade non-asbestos packing.
.6 Handwheel: non-ferrous.
.7 Handwheel Nut: bronze to ASTM B62.
.2 NPS 2 and under, composition disc, Class 125:
.1 Body and bonnet: screwed bonnet.
.2 Disc and seat: renewable rotating PTFE disc, composition to suit service conditions, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.

.3 Operator: Handwheel.

.3 NPS 2 and under, composition disc, Class 150:
- .1 Body and bonnet: union bonnet.
- .2 Disc and seat: renewable rotating PTFE disc in easily removable disc holder, regrindable bronze seat, loosely secured to bronze stem to ASTM B505.
- .3 Operator: Handwheel.

.4 NPS 2 and under, plug disc, Class 150, screwed ends:
- .1 Body and bonnet: union bonnet.
- .2 Disc and seat ring: tapered plug type with disc stem ring of AISI S420 stainless steel to ASTM A276, loosely secured to stem.
- .3 Operator: Handwheel.

.5 Angle valve, NPS 2 and under, composition disc, Class 150:
- .1 Body and bonnet: union bonnet.
- .2 Disc and seat: renewable rotating PTFE disc in slip-on easily removable disc holder having integral guides, regrindable bronze seat, loosely secured to stem.
- .3 Operator: Handwheel.

.6 Check Valves:

.1 Requirements common to check valves, unless specified otherwise:
- .1 Standard specification: MSS SP-80.
- .2 Connections: screwed with hexagonal shoulders.

.2 NPS 2 and under, swing type, bronze disc, Class 125:
- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.3 NPS 2 and under, swing type, bronze disc:
- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.

.4 NPS 2 and under, swing type, composition disc, Class 200:
- .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
- .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.

.5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
- .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
- .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.

.6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
- .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.

.7 Silent Check Valves:

.1 NPS 2 and under:
- .1 Body: cast high tensile bronze to ASTM B62 with integral seat.
- .2 Pressure rating: Class 125.
- .3 Connections: screwed ends to ANSI B1.20.1 and with hex shoulders.
- .4 Disc and seat: renewable rotating disc.

.5 Stainless steel spring, heavy duty.
.6 Seat: regrindable.

.8 Ball Valves:
.1 NPS 2 and under:
.1 Body and cap: cast high tensile brass to C37700.
.2 Pressure rating: Class 150 WSP/600 WOG.
.3 Connections: Screwed ends to ANSI B1.20.1 and with hexagonal shoulders or solder ends to ANSI.
.4 Stem: tamperproof ball drive.
.5 Stem packing nut: external to body.
.6 Ball and seat: replaceable solid hard chrome full port ball and teflon seals.
.7 Stem seal: TFE with external packing nut.
.8 Operator: removable lever handle.

3 Execution

3.1 INSTALLATION

.1 Install rising stem valves in upright position with stem above horizontal.

.2 Remove internal parts before soldering.

.3 Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal. Refer to 23 05 05 - Installation of Pipework.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Concrete housekeeping pads, hangers and supports for mechanical piping, ducting and equipment.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
- .1 ANSI/ASME B31.1-04, Power Piping.

.2 American Society for Testing and Materials International (ASTM)
- .1 ASTM A125-1996(R2001), Specification for Steel Springs, Helical, Heat-Treated.
- .2 ASTM A307-04, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .3 ASTM A563-04a, Specification for Carbon and Alloy Steel Nuts.

.3 Factory Mutual (FM)

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

.5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
- .1 MSS SP58-2002, Pipe Hangers and Supports - Materials, Design and Manufacture.
- .2 ANSI/MSS SP69-2003, Pipe Hangers and Supports - Selection and Application.
- .3 MSS SP89-2003, Pipe Hangers and Supports - Fabrication and Installation Practices.

.6 Underwriter's Laboratories of Canada (ULC)

1.3 SYSTEM DESCRIPTION

.1 Design Requirements:
- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing manufacturers' regular production components, parts and assemblies.
- .2 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS SP58.
- .3 Ensure that supports, guides, anchors do not transmit excessive quantities of heat to building structure.
- .4 Design 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 and prevent vibration.
- .5 Provide for vertical adjustments after erection and during commissioning. Amount of adjustment in accordance with MSS SP58.
- .6 Pipe supports shall meet the requirements of ASME B31.1 Power Piping and ASME B31.9 Building Services Piping.

.7 Automatic sprinkler pipe supports shall meet the requirements of NFPA No. 13, Standard for Installation of Sprinkler Systems.

.8 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.9 Select hangers and supports for the service and in accordance with the manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.10 Fasten hangers and supports to building steel or inserts in concrete construction.

.11 Provide and set sleeves required for equipment, including openings required for placing equipment.

.12 Obtain approval prior to drilling for inserts and supports for piping systems.

.13 Obtain approval prior to using percussion type fastenings.

.14 Use of existing piping or equipment for hanger supports is not permitted.

.15 Use of perforated band iron, wire or chain as hangers is not permitted.

2 Products

2.1 GENERAL

.1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1, ASME B31.9 and MSS SP58.

.2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

.3 Design hangers so they cannot become disengaged by movements of supported pipe.

2.2 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized after manufacture.

.2 Use electro-plating galvanizing process or hot dipped galvanizing process.

.3 Ensure steel hangers in contact with copper piping are copper plated.

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 Cold piping NPS 2 maximum: malleable iron C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip.

.1 Rod: to be UL listed.

.2 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-SP58 and MSS-SP69.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, UL listed to MSS SP69.

.2 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 SP69.

.5 Shop and field-fabricated assemblies:
- .1 Trapeze hanger assemblies: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm and over.
- .2 Steel brackets: Welded and wrought steel clamp.

.6 Hanger rods: threaded rod material to MSS SP58:
- .1 Ensure that hanger rods are subject to tensile loading only.
- .2 Provide linkages where lateral or axial movement of pipework is anticipated.
- .3 Threaded both ends, one end or continuous.

.7 Pipe attachments: material to MSS SP58:
- .1 Attachments for steel piping: carbon steel black.
- .2 Attachments for copper piping: copper plated black steel.
- .3 Use insulation shields for hot pipework.
- .4 Oversize pipe hangers and supports.

.8 Adjustable clevis: material to MSS SP69 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 SP69.

.10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
- .1 Finishes for steel pipework: black.
- .2 Finishes for copper, glass, brass or aluminum pipework: black, with formed portion plastic coated.

.11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

.12 Wall Support:
- .1 Up to 75 mm: Cast iron hook.
- .2 100 mm and over: Welded steel bracket and wrought steel clamp.

.13 Floor Support:
- .1 Pipe sizes up to 100 mm and all cold pipe sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.
- .2 Hot pipe sizes 150 mm and over: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

2.3 RISER CLAMPS

.1 Steel or cast iron pipe: black carbon steel to MSS SP58, type 42, UL listed.

.2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.3 Bolts: to ASTM A307.

.4 Nuts: to ASTM A563.

2.4 INSULATION PROTECTION SHIELDS

.1 Insulated cold piping:

.1 64 kg/m^3 density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.

.2 Insulated hot piping:

.1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

2.5 CONSTANT SUPPORT SPRING HANGERS

.1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).

.2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.

.3 Provide upper and lower factory set travel stops.

.4 Provide load adjustment scale for field adjustments.

.5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.

.6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

2.6 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. Provide certificate of calibration for each hanger.

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

2.7 EQUIPMENT SUPPORTS

.1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

2.8 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

.1 Provide templates to ensure accurate location of anchor bolts.

2.9 SLEEVES

.1 Pipes through floors: Form with 18 gauge galvanized steel.

.2 Pipes through beams, walls, fire proofing, footings, potentially wet floor: Form with steel pipe or 18 gauge galvanized steel.

.3 Size large enough to allow for movement due to expansion and to provide for continuous insulation.

2.10 OTHER EQUIPMENT SUPPORTS

.1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.

.2 Submit structural calculations with shop drawings.

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 manufacturer's instructions and recommendations.

.2 Vibration Control Devices:
- .1 Install on piping systems at pumps, at all vibration isolated equipment and as indicated.

.3 Clamps on riser piping:
- .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
- .2 Bolt-tightening torques to industry standards.
- .3 Steel pipes: install below coupling or shear lugs welded to pipe.
- .4 Cast iron pipes: install below joint.

.4 Clevis plates:
- .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.

.5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.

.6 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.

.7 Use variable support spring hangers where:
- .1 Transfer of load to adjacent piping or to connected equipment is not critical.
- .2 Variation in supporting effect does not exceed 25% of total load.

3.3 INSERTS

.1 Use inserts for suspending hangers for reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 100 mm.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

3.4 HANGER SPACING

.1 Plumbing piping: to Canadian Plumbing Code, Provincial Code, authority having jurisdiction.

.2 Fire protection: to applicable Fire Code.

.3 Copper piping: up to NPS 1/2: every 1.5 m.

.4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.

.5 Within 300 mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper	Rod Diameter
up to 32 mm	1.8 m	1.8 m	9.5 mm
38 mm	1.8 m	1.8 m	9.5 mm
50 mm and 63 mm	3.0 m	3.0 m	9.5 mm
75 mm - 100 mm	3.6 m	3.0 m	15.8 mm
150 mm - 200 mm	4.3 m	4.3 m	22.2 mm

.6 Install hangers to provide a minimum 12 mm clear space between finished covering and adjacent work.

3.5 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.

.4 Use hangers which are vertically adjustable 38 mm minimum after piping is erected.

.5 Support horizontal soil pipe near each hub, with 1.5 m maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Hangers: Pipe sizes 12 mm to 38 mm: Adjustable wrought steel ring.

.10 Hangers: Pipe sizes 50 mm to 100 mm and Cold Pipe Sizes: Adjustable wrought steel clevis.

3.6 SLEEVES

.1 Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.

.2 Extend sleeves through potentially wet floors 25 mm above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Where piping passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Install chrome plated escutcheons where piping passes through finished surfaces.

.5 All penetrations through fire rated walls, floors or partition assemblies shall be sealed/fire stopped with fire stop materials that will remain in place and prevent the passage of smoke, toxic gases, flame, etc., when subjected to the standard test method Can 4-S115, "Standard Method of Fire Tests for Firestop Systems" for a period of time equal to fire protection rating required for the grade of fire separation of the penetrated wall or floor.

.6 Acceptable Product: According to instructions provided, all penetrations in fire rated walls, floors, or partition assemblies shall be sealed/fire stopped with:

- .1 3M Brand Intumescent, "Fire Barrier" Caulk CP-25, Putty 303, Penetration Sealing Systems 7902 or 7904 Series, Composite Sheet CS-195, or Wrap Strip FS-195.
- .2 Tremco Firestop Systems: Fyresil, Fyreshield for penetrations and perimeters. Dymeric ULC, THC 900 ULC

3.7 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.

3.8 FINAL ADJUSTMENT

.1 Adjust hangers and supports:
- .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.

3.9 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.

.2 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 - 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 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

END OF SECTION

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.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 Canadian Gas Association (CGA)
- .1 CSA/CGA B149.1-05, Natural Gas and Propane Installation Code.

.2 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.

.3 National Fire Protection Association (NFPA)
- .1 NFPA 13-2002, Standard for the Installation of Sprinkler Systems.
- .2 NFPA 14-2003, Standard for the Installation of Standpipe and Hose Systems.

1.3 QUALITY ASSURANCE

.1 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:
- .1 Equipment: manufacturer's name, model, size, serial number, capacity.
- .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:
- .1 Hazardous: red letters, white background.
- .2 Elsewhere: black letters, white background (except where required otherwise by applicable Codes).

.2 Construction:
- .1 3 mm thick laminated plastic or white anodized aluminum, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20

.2 Use maximum of 25 letters/numbers per line.

.4 Locations:

.1 Terminal cabinets, control panels: use size #5.

.2 Equipment in Mechanical Rooms: use size #9.

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment in Mechanical Room:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

.1 Apply existing identification system to new work.

.2 Where existing identification system does not cover for new work, use identification system specified this section.

2.4 PIPING SYSTEMS GOVERNED BY CODES

.1 Identification:

.1 Natural gas: to CSA/CGA B149.1 and authority having jurisdiction.

.2 Sprinklers: to NFPA 13.

2.5 IDENTIFICATION OF PIPING SYSTEMS

.1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.

.2 Pictograms:
- .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.

.3 Legend:
- .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.

.4 Arrows showing direction of flow:
- .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
- .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
- .3 Use double-headed arrows where flow is reversible.

.5 Extent of background colour marking:
- .1 To full circumference of pipe or insulation.
- .2 Length to accommodate pictogram, full length of legend and arrows.

.6 Materials for background colour marking, legend, arrows:
- .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
- .2 Other pipes: pressure sensitive plastic-coated cloth or vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:
- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
City water	Green	CITY WATER
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply - hard	Green	DOM. CHW

Contents	Background colour marking	Legend
Domestic cold soft supply - hard	Green	DOM. CSW
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Fire protection water	Red	FIRE PROT. WTR
Sprinklers	Red	SPRINKLERS

2.6 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 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.

2.8 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.

2.9 LANGUAGE

.1 Identification in English.

2.10 EQUIPMENT WITHIN CEILING SPACE

.1 Provide identification on the ceiling for all equipment concealed within a ceiling space.

.2 Equipment Labels:
- .1 Colours: Black lettering on transparent background.
- .2 Height of letter: 5 mm.
- .3 T-bar ceilings: Label shall be located on the metal ceiling grid beside the ceiling tile that provides service access to the equipment. The label shall include the equipment tag and an arrow indicating the ceiling tile to remove for servicing and access to the equipment.
- .4 Solid ceilings: Label shall be located on the trim of the access panel used for servicing the equipment and include the equipment tag.

.3 Colour Coded Dots:
- .1 Confirm site standard colour coding with the Departmental Representative prior to commencing work. Coordinate with all trades.
- .2 Provide a Legend in the operating and maintenance manual identifying the colour coding utilized on site.

.3 T-bar ceilings: Dot shall be located on the metal ceiling grid beside the ceiling tile that provides service access to the equipment.

.4 Solid ceilings: Dot shall be located on the trim of the access panel used for servicing the equipment.

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 painting specified Section 09 91 23 - Interior Painting has been completed.

3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or CSA registration plates as required by respective agency.

.3 Identify systems, equipment to conform to PWGSC PMSS.

3.4 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate or cover.

3.5 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS

.1 On long straight runs in open areas in boiler rooms, equipment rooms, galleries, tunnels: at not more than 17 m intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.

.2 Adjacent to each change in direction.

.3 At least once in each small room through which piping or ductwork passes.

.4 On both sides of visual obstruction or where run is difficult to follow.

.5 On both sides of separations such as walls, floors, partitions.

.6 Where system is installed in pipe chases, ceiling spaces, galleries, confined spaces, at entry and exit points, and at access openings.

.7 At beginning and end points of each run and at each piece of equipment in run.

.8 At point immediately upstream of major manually operated or automatically controlled valves, and dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.9 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.

3.6 VALVES, CONTROLLERS

.1 Valves and operating controllers, except at plumbing fixtures, radiation, or where in plain sight of equipment they serve: Secure tags with non-ferrous chains or closed "S" hooks.

.2 Install one copy of flow diagrams, valve schedules mounted in frame behind non-glare glass where directed by Departmental Representative. Provide one copy (reduced in size if required) in each operating and maintenance manual.

.3 Number valves in each system consecutively.

3.7 ELECTRIC SWITCH

.1 Identify electric starting switches and remote push button stations with 6 mm laminated plastic plates.

3.8 AUTOMATIC CONTROLS

.1 Tag automatic controls, instruments, and relays and key to controls schematic on which instruments are numbered in sequence.

3.9 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.

END OF SECTION

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 Departmental Representative within 90 days of award of contract.

.2 Provide documentation confirming qualifications, successful experience.

.3 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.

.4 Recommendations and suggested practices contained in the TAB Standard: mandatory.

.5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.

.6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.

.7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.8 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.

1.6 PRE-TAB REVIEW

.1 Review contract documents before project construction is started and confirm in writing to Departmental 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 Departmental 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.

.2 Follow start-up procedures specified elsewhere in Division 23 in accordance with manufacturer’s requirements.

1.8 OPERATION OF SYSTEMS DURING TAB

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

1.9 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weatherstripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 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 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.
  - .6 Chemical treatment systems complete, operational.

1.10 APPLICATION TOLERANCES

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

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 Departmental 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 Departmental Representative and include TAB report.

1.13 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 Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
- .1 Details of instruments used.
- .2 Details of TAB procedures employed.
- .3 Calculations procedures.
- .4 Summaries.

1.15 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:
- .1 Project record drawings.
- .2 System schematics.

.3 Submit 4 copies of TAB Report to Departmental 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 Departmental Representative.

.2 Provide personnel and instrumentation to verify up to 30 % of reported results.

.3 Number and location of verified results as directed by Departmental Representative.

.4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

1.17 SETTINGS

.1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, and insure 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 Departmental Representative.

1.19 AIR SYSTEMS

.1 Standard: TAB to most stringent of SMACNA.

.2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls.

.3 Qualifications: personnel performing TAB qualified to standards of AABC or NEBB.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC or NEBB.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:
- .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
- .2 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 OTHER TAB REQUIREMENTS

.1 General requirements applicable to work specified this paragraph:
- .1 Qualifications of TAB personnel: as for air systems specified this section.
- .2 Quality assurance: as for air systems specified this section.

.1 Zone pressure differences:
- .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.

.2 Smoke management systems:
- .1 Test for proper operation of all smoke and fire dampers, sensors, detectors, installed or modified as component parts of air systems specified Division 23.

1.21 BALANCE REPORTS

.1 Balance reports to include the following at minimum (data shall always include design and actual measured data):
- .1 Title Page: Company Name, Address, and Telephone Number; Project Name, Location, Architect, Engineer, and Project Contractor.
- .2 Include types, serial number and dates of calibration of instruments used.
- .3 Air Handling Units: Location, Local Identification, Manufacturer, Model, Size, Arrangement, discharge and class, Supply Air Flow, Return Air Flow, Outside Air Flow, Static Pressures, Fan RPM, inlet and outlet dry bulb and wet bulb temperatures.
- .4 Duct air quantities: Mains, Branches, Outside Air and Exhausts (Maximum and Minimum), Duct sizes; Number of pressure readings; Sum of velocity measurements; Average velocity; duct air flow rate.
- .5 Exhaust Fan Data: Location, Manufacturer, Model, Specified and Actual Air Flow, Static Pressure, and Fan RPM.
- .6 Electric Motors: Manufacturer, HP/BHP, Phase, Voltage, Amperage (maximum operating and full load), RPM, Service Factor, Starter Heater Elements.
- .7 V-Belt Drive: Identification/Location, Driven Sheave Diameter and RPM belt Size and Quantity, Motor Sheave Diameter and RPM.
- .8 Air Distribution: Terminal Number, Room Number/Location, Terminal Type and Size, Area Factor, Design Velocity and Air Flow, Test Velocity and Air Flow.
- .9 Air Inlets and Outlets: Outlet identification location and Designation; Manufacturer's catalogue identification and type; Application factors; air velocities; air flow rates; Deflector vane or diffuser cone settings.
- .10 Coil Data: Location, Identification/Number, Service, Manufacturer, Element type, Air Flow Rate, Entering Air and Leaving Air Temperatures (dry bulb and wet bulb), Water Flow rate and Pressure Drop, Entering and Leaving Water Temperatures, energy transfer rate.
- .11 Terminal Heating/Cooling Equipment (radiation, panels, in-floor etc.): Location, Element Type, Designation, Manufacturer, Entering and Leaving Water Temperatures, Length of Fin, Water Pressure drops, Water Flow Rates. If a steam system include steam pressure, temperature and condensate temperature. If a heating/cooling system provide data for both modes of operation. Provide total flow for in-floor manifold.

2 Products

2.1 NOT USED

.1 Not used.

3 Execution

3.1 PREPARATION

.1 Before adjusting and balancing, verify that systems are complete and operable. Ensure temperature control systems are complete and operable, thermal overload protection is in place, final filters installed, hydronic systems, flushed, filled, and vented.

.2 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.

.3 Recorded data shall represent actually measured, or observed condition.

3.2 GENERAL PROCEDURES

.1 Balance to maximum measured flow, allowable deviation as specified.

.2 Permanently mark settings on valves, splitters, dampers, and other adjustment devices.

.3 Subsequent to correctional work, take measurements to verify balance has not been disrupted or that any such disruption has been rectified.

.4 At final inspection, re-check random selections of data recorded in report. Re-check points of areas as selected and witnessed by the Owner.

.5 Check and adjust systems approximately six (6) months after final acceptance and submit report.

.6 The Balancing Contractor shall include the cost of sheave changes necessary to achieve specified air flow within limits specified.

3.3 AIR SYSTEM PROCEDURES

.1 Adjust air handling and distribution systems to provide required or design supply, return and exhaust air quantities. Permanently mark settings of damper and other adjustment devices allowing settings to be restored.

.2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross-sectional area of duct.

.3 Measure air quantities at each air inlet and outlet. Use volume control devices to regulate air quantities.

.4 Vary total system air quantities by adjustment of fan speeds. Where Variable Frequency Drives (VFDs) are installed, utilize VFDs to adjust fan speed. Provide drive changes where required.

.5 Where modulating dampers are provided, take measurements and balance at extreme

conditions. Balance variable volume systems at maximum air flow rate - full cooling, and at minimum air flow rate - full heating.

.6 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

.7 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

3.4 WATER SYSTEM PROCEDURE

.1 Adjust water systems to provide required or design quantities. Permanently mark settings of valves and other adjustment devices allowing settings to be restored. Set and lock memory stops.

.2 Use calibrated venturi tubes, orifices, or other metered fittings and pressure gauges in conjunction with permanent and portable type flow meters to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.

.3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

.4 Effect system balance with automatic control valves fully open to heat transfer elements.

.5 Effect adjustment of water distribution systems by means of balancing cocks, valves and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

.6 Where pump capacity available is less than total flow requirements or individual system parts, full flow in any part may be simulated by temporary restriction of flow to other parts.

.7 Where flow restrictors are used provide record data of air and water inlet and outlet temperatures at design conditions.

END OF SECTION

1 General

1.1 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
- .1 ANSI/ASHRAE/IESNA 90.1-01, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 American Society for Testing and Materials International, (ASTM)
- .1 ASTM B209M, Specification for Aluminum and Aluminum Alloy Sheet and Plate (Metric).
- .2 ASTM C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
- .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
- .5 ASTM C547, Specification for Mineral Fiber Pipe Insulation.
- .6 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .7 ASTM C612, Specification for Mineral Fiber Block and Board Thermal Insulation.
- .8 ASTM C795, Specification for Thermal Insulation for Use with Austenitic Stainless Steel.
- .9 ASTM C921-(1998)e1, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.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 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (R1999).

.5 Underwriters Laboratories of Canada (ULC)
- .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701, Thermal Insulation Polyotrene, Boards and Pipe Covering.

1.2 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" - will mean "not concealed" as defined herein.
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

.2 TIAC Codes:
- .1 CRD: Code Round Ductwork,
- .2 CRF: Code Rectangular Finish.

1.3 SHOP DRAWINGS

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

.2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

1.4 MANUFACTURERS' INSTRUCTIONS

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

.2 Installation instructions to include procedures used, and installation standards achieved.

1.5 QUALIFICATIONS

.1 Installer: specialist in performing work of this section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

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 includes glass fibre, rock wool, slag wool.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 deg.C mean temperature when tested in accordance with ASTM C335. Maximum “K” factor to be 0.034 W/m. deg.K (0.24 BTU in/hr/sq.ft. Deg.K) to ASTM C5553.

.3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with or without 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 ASTM C553 faced with or without factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
- .1 Mineral fibre: to ASTM C553.
- .2 Jacket: to CGSB 51-GP-52Ma.

2.3 JACKETS

.1 Canvas:
- .1 ULC listed treated cotton fabric, 220 g/sq.m. to ASTM C 921.

.2 Lagging adhesive: Compatible with insulation.

.3 Aluminum:
- .1 To ASTM B209 with or without moisture barrier as scheduled in PART 3 of this section.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: Smooth.
- .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
  - .1 Stainless steel:
- .5 Type: 316.
- .6 Thickness: 0.25 mm sheet.
- .7 Finish: Stucco embossed.
- .8 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:
- .1 Water based, fire retardant type, compatible with insulation.

.2 Indoor Vapour Retarder Finish:
- .1 Vinyl emulsion type acrylic, compatible with insulation.

.3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.

.4 Outdoor Vapour Retarder Mastic:
- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m^2.

.5 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.

.6 Contact adhesive: quick-setting

.7 Tie wire: 1.5 mm stainless steel.

.8 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.9 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on one face of insulation.

.10 Fasteners: 4 mm diameter pins with 35 mm diameter or square clips, length to suit thickness of insulation.

.11 Adhesives to be waterproof.

3 Execution

3.1 PRE-INSTALLATION REQUIREMENTS

.1 Pressure testing of ductwork systems complete, witnessed and certified.

.2 Surfaces clean, dry, free from foreign material.

3.2 INSTALLATION

.1 Install in accordance with TIAC National Standards.

.2 Apply materials in accordance with manufacturer's instructions and as indicated.

.3 Use two layers with staggered joints when required nominal thickness exceeds 75 mm.

.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 - Hangers and Supports for HVAC Piping and Equipment.
- .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.

.6 Fasteners: At 300 mm oc in horizontal and vertical directions, minimum two rows each side.

.7 Ensure insulation is continuous through inside walls. Pack around ducts with fire proof self-supporting insulation material, properly sealed.

.8 Finish insulation neatly at hangers, supports and other protrusions.

.9 Locate insulation or cover seams in least visible locations.

.10 Provide recovering jackets on exposed insulation throughout, including equipment roof. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Use pre-sized paper under recovering at uneven insulated surfaces.

.11 Exposed Rectangular Ducts: Secure rigid insulation with 50% coverage of adhesive and 12 gauge galvanized impale anchor tabs on 400 mm centres. Seal joints and breaks with 250 mm wide strips of open mesh glass cloth or tape imbedded between two coats of vapour barrier sealant. Point up other joints and breaks with hydraulic setting cement.

.12 Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 150 mm wide strips on 400 mm centres. Provide 16 gauge annealed tie wire tied, spiral wound or half hitched at 200 mm centres for securing duct insulation until adhesive sets. Butt insulation and seal joints and breaks with 50 mm lap of foil adhered over joint.

.13 Acoustic Lining: Apply to interior of ducts where shown. Secure to ductwork with adhesive using 100% coverage and 12 gauge impale anchor tabs on 400 mm centres. Cut off excess fastener length and cover with brush coat of mastic. Use 25 mm thick insulation unless otherwise noted. Provide vapour barrier located on the warm side for outside air intakes. Ducts with acoustic insulation do not require external thermal insulation. Lining to be coated or lined to prevent fibre-erosion at air velocities up to 20 m/s (4000 fmp)

.14 To match existing finishes, exposed high velocity ductwork to be complete with canvas recovery jacket

3.3 DUCTWORK INSULATION SCHEDULE

.1 Insulation types and thicknesses: Conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	C-1	yes	50
Round cold and dual temperature supply air ducts	C-2	yes	50
Rectangular warm air ducts	C-1	no	25
Round warm air ducts	C-1	no	25
Exhaust duct between dampers and louvres	C-1	no	25
Acoustically lined ducts	none		25

.2 HERE 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.

.1 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/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

END OF SECTION

1 General

1.1 SUMMARY

1. Section Includes:
   .1 Thermal insulation for piping and piping accessories.

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
   .1 ASHRAE Standard 90.1-01, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).

.2 American Society for Testing and Materials International (ASTM)
   .1 ASTM B209M-04, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate Metric.
   .2 ASTM C335-04, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
   .3 ASTM C411-04, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
   .4 ASTM C449/C449M-00, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
   .5 ASTM C533-2004, Calcium Silicate Block and Pipe Thermal Insulation.
   .6 ASTM C547-2003, Mineral Fiber Pipe Insulation.
   .7 ASTM C795-03, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
   .8 ASTM C921-03a, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)
   .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
   .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketting Sheet, for Insulated Pipes, Vessels and Round Ducts

.4 Department of Justice Canada (Jus)
   .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
   .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
   .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
   .1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Trade Associations
   .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).

.7 Underwriters' Laboratories of Canada (ULC)
- .1 CAN/ULC-S102-03, Surface Burning Characteristics of Building Materials and Assemblies.
- .2 CAN/ULC-S701-01, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .3 CAN/ULC-S702-1997, Thermal Insulation, Mineral Fibre, for Buildings
- .4 CAN/ULC-S702.2-03, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 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.

1.4 QUALITY ASSURANCE

.1 Installer: specialist in performing work of this Section, and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

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 and rock wool. Insulation on steam lines to be rock wool only, glass fibre is not permitted.

.2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335. Mineral fibre maximum thermal conductivity “K” to be 0.034 W/m. deg.K (0.24 BTU in/hr/sq.ft. Deg.F). Elastomer closed cell insulation maximum thermal conductivity “K: to be 0.04 W/M deg.K (0.28 BTU in/hr/sq.ft. Deg.F).

.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.

.5 TIAC Code C-2: mineral fibre blanket faced with or without factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
- .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.

.6 TIAC Code A-6: flexible unicellular tubular elastomer.
- .1 Insulation: with vapour retarder jacket.
- .2 Maximum water transmission rating of 0.1 perms.

2.3 REMOVABLE, PRE-FABRICATED INSULATING ENCLOSURES

.1 Use of insulating materials other than those stated in this specification requires Departmental Representative's approval. Standard of acceptance for re-usable insulation blankets shall be Reflex Re-usable flexible insulation covers.

.2 All materials shall be of flame resistant materials.

.3 Re-usable flexible insulation blanket outer jacket material shall be 0.26 kg/m2. Teflon coated fibreglass cloth.

.4 Material used to secure seams and attachments on re-usable flexible insulation blankets shall be 10 strand stainless steel thread with polyester wrap.

.5 Re-usable flexible insulation blanket liner material shall be 560 grams/m2 Teflon coated fibreglass cloth for operating temperatures up to 232 deg.C.

.6 Minimum insulation thickness shall be 25 mm insulation for operating temperatures up to 232 deg.C.

.7 Insulation materials shall be Type E needled fibreglass mat containing no organic binders and no less than 11 pound density for operating temperatures up to 538 deg.C.

.8 Fasteners shall be velcro closures incorporated with seam flaps in conjunction with sewn on straps and stainless steel D rings.

.9 Flaps shall be used to cover all closing seams and cover slots. The flaps shall be 50 mm wide plain flaps for operating temperatures up to 232 deg.C.

.10 6 mm matrix braded Nomex draw-cord closures shall be used on cover openings over 50 mm in diameter. Close the ends of covers over adjacent insulation or piping.

.11 Quilting fasteners shall be 14 gauge stainless steel quilt pins and locking washers.

.12 A stainless steel drain grommet, 11 mm in diameter, shall be installed at the low point on the cover.

.13 A permanent stainless steel or aluminum identification tag shall be attached to each blanket. Tags shall be secured to the re-usable blanket with aluminum rivets and shall be installed in the most visible location on the blanket.

.14 Re-usable flexible insulation blanket construction:
- .1 Blankets up to 25 mm thick shall be inside seam construction with double stitching, with the liner and jacket material sewn together to form the insulation pocket.
  - .1 Perimeter flaps shall be formed as an extension of the liner and jacket, and shall not be attached to blanket as separate pieces.
  - .2 All blankets up to 25 mm thick must be double stitched. First stitch will be performed with cloth layers sewn together inside out. Blanket will then be turned right side out and top stitched around all penetrations and around the perimeter of the insulation pocket to create a separation between the insulation pocket and the perimeter flaps.
  - .3 All draw-cord and closure flaps, required inside the perimeter of the blanket shall be attached inside the seam, between the liner and jacket layers of the blanket.
- .2 Blankets over 25 mm thick shall be constructed using boxed corners and gussets in order to maintain consistent thickness across the entire area of the blanket.
  - .1 Perimeter flaps shall be formed as an extension of the outer jacket, and shall not be attached to the blanket as separate pieces.
  - .2 All draw-cord and closure flaps, required inside the perimeter of the blanket, shall be attached inside the seam, between the liner and jacket layers of the blanket.

2.4 INSULATION SECUREMENT

.1 Tape: self-adhesive, aluminum, plain, 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.

2.5 CEMENT

.1 Thermal insulating and finishing cement:
- .1 Hydraulic setting on mineral wool, to ASTM C449/C449M.

2.6 VAPOUR RETARDER LAP ADHESIVE

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

2.7 INDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

2.8 OUTDOOR VAPOUR RETARDER FINISH

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: fibrous glass, untreated 305 g/m^2.

2.9 JACKETS

.1 Aluminum:
- .1 To ASTM B209.
- .2 Thickness: 0.50 mm sheet.
- .3 Finish: stucco embossed.
- .4 Joining: longitudinal and circumferential slip joints with 50 mm laps.
- .5 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.

2.10 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS

.1 Caulking to: Section 07 92 10 - Joint Sealing.

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 manufacturer’s 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.

.6 Perform work at ambient and equipment temperatures, as recommended by the adhesive manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

.7 Ensure installation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.8 Insulate fittings and valves. Do not insulate unions, flanges, strainers, flexible connections and expansion joints in Equipment Rooms. Terminate insulation neatly.

.9 Finish insulation neatly at hangers, supports and other protrusions.

.10 Locate insulation or cover seams in least visible locations.

.11 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces are not considered exposed. Aluminum jacket to be installed as per manufacturer's recommendations.

.12 Cover insulation exposed to outdoors with 16.5 kg/sq.m. coated glass base sheet with aluminum bands on 200 mm centres. Lap joints 75 mm minimum and seal with compatible waterproof lap cement.

.13 Cold Piping: Cover fittings and valves with equivalent thickness of insulation material. Cover with open mesh glass cloth sealed with vapour barrier sealant. Seal lap joints with 100% coverage of vapour barrier sealant and adhesive. Seal butt joints with 100 mm wide strips of vapour barrier sealed with vapour barrier adhesive. For exposed fittings and valves, apply hydraulic setting cement paste over insulation material before applying recovering.

.14 Hot Piping: Cover fittings and valves with equivalent thickness of insulation material. Recover. For exposed fittings and valves apply hydraulic setting cement paste over insulating material before applying recovering.

.15 Roof Drains, Vents and Coil Drains: Adhere flexible insulation with adhesive applied win 150 mm wide strips on 400 mm centres. Provide 16 gauge annealed tie wire tied, spiral wound or half hitched at 400 mm centres for securing insulation until adhesive sets. Butt insulation and seal joints and breaks with 50 mm of foil adhered over joint.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

.1 Removable insulation bags must be provided for the following: control valves, unions or flanges at equipment, and flanged valves, expansion joints, PRVs.

.2 Design: to permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.

.3 Blankets on flanged valves and equipment shall be designed to cover adjacent mating flanges and overlap line insulation by a minimum of 50 mm. Allowance of stud length plus 25 mm from the back of the mating flange shall be used to calculate the cut back distance of line insulation. Draw-cold flaps shall not be considered as part of the overlap.

.4 Blankets on valves shall be designed to cover the valve body and the bonnet flange of the valve.

.5 Blankets for pressure gauges include block and bleed valve.

.6 Blankets for PSV's shall include the outlet flange. Blanket shall cover entire spring chamber.

.7 All blankets shall be fitted with an identification tag clearly marked with the following information:

.1	Equipment size and type	i.e. 6" 300# Control Valve
.2	Equipment location and tag number	i.e. 21-PV-129
.3	Manufacturer's Serial Number	i.e SN01010

.8 All equipment shall be field measured by blanket supplier. Measurements shall be performed after equipment is installed. All necessary allowances for the blankets shall be coordinated between the blanket supplier and the mechanical, electrical and insulation Contractors.

.9 Existing insulation bags will all be salvaged. Contractor may reuse bags on this project. All unused bags will be turned over to Owner.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

.1 Insulation to remain dry. Overlaps to manufacturer's 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 150 mm on centre.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code 1501-H.
- .4 Aluminum jacket.

.3 TIAC Code: A-3.
- .1 Securements: SS bands at 150 mm on centre.
- .2 Seals: VR lap seal adhesive, VR lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.
- .4 Aluminum jacket.

.4 TIAC Code: C-2 with vapour retarder jacket.
- .1 Insulation securements.
- .2 Seals: lap seal adhesive, lagging adhesive.
- .3 Installation: TIAC Code: 1501-C.
- .4 Aluminum jacket.

.5 TIAC Code: A-6.
- .1 Seals: lap seal adhesive, lagging adhesive.
- .2 Installation: to TIAC standards.

.6 Thickness of insulation as listed in following table.
- .1 Run-outs to individual units and equipment not exceeding 4000 mm long.

.2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp deg. 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
Hot Water Heating	60 - 94	A-1	25	38	38	38	38
Domestic DHW		A-1	25	25	25	38	38
Chilled Water	4 - 13	A-3	25	25	25	25	25
Domestic DCW		A-3	25	25	25	25	25

.7 Finishes:
- .1 Exposed indoors: Stucco embossed aluminum jacket.
- .2 Exposed in mechanical rooms: Stucco embossed aluminum jacket.
- .3 Concealed, indoors: Stucco embossed aluminum jacket.
- .4 Use vapour retarder jacket on TIAC code A-3 insulation compatible with insulation.
- .5 Outdoors: water-proof stucco embossed aluminum jacket.
- .6 Finish attachments: SS bands, at 150 mm on centre. Seals: closed.
- .7 Installation: to appropriate TIAC code CRF/1 through CPF/5.
- .8 High temperature fabric on all removable insulation bags.

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.

END OF SECTION

1 General

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.2 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

.1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.

.2 When systems are operational, perform following tests:
- .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.

1.3 POTABLE WATER SYSTEMS

.1 When cleaning is completed and system filled:
- .1 Verify performance of equipment and systems as specified elsewhere in Division 23.
- .2 Check for proper operation of water hammer arrestors. Run one outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or recharge air chambers. Repeat for each outlet and flush valve.
- .3 Confirm water quality consistent with supply standards, verifying that no residuals remain resulting from flushing and/or cleaning.

1.4 WET AND DRY PIPE SPRINKLER SYSTEM, STANDPIPE AND HOSE SYSTEMS

.1 Cleaning, testing, start-up, performance verification of equipment, systems, components, and devices is specified elsewhere in Division 23.

.2 Verification of controls, detection devices, alarm devices is specified Division 26.

.3 Verify operation of interlocks between HVAC systems and fire alarm systems as required by Code or specified.

1.5 REPORTS

.1 Include record of all tests in Operation and Maintenance Manuals.

1.6 TRAINING

.1 In accordance with Section 23 05 02 - General Mechanical Provisions.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 The supply and installation of Hydronic Specialties Equipment.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).
  .1 ASME-04, Boiler and Pressure Vessel Code.

.2 American Society for Testing and Materials, (ASTM).
  .1 ASTM A47/A47M-99, Specification for Ferritic Malleable Iron Castings.
  .2 ASTM A278M-01, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (345 degrees C).
  .3 ASTM A516/A516M-96(e1), Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  .4 ASTM A536-84(1999)e1, Specification for Ductile Iron Castings.
  .5 ASTM B62-93, Specification for Composition Bronze or Ounce Metal Castings.

.3 Canadian Standards Association (CSA International).
  .1 CSA B51-03, Boiler, Pressure Vessel, and Pressure Piping Code.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 02 61 33 - Hazardous Materials.
  .1 Submit shop drawings and product data in accordance with Section 01 33 00 - Submital Procedures.
  .2 Indicate on product data expansion tanks, air vents, separators, valves, strainers.

.3 Closeout Submittals:
  .1 Submit maintenance data in accordance with Section 01 78 00 - Closeout Submittals.

2 Products

2.1 AUTOMATIC AIR VENT

.1 Industrial float vent: cast iron body with stainless steel, brass and epdm internal components and NPS 19 mm inlet connection, 9.5 mm discharge and rated at 1034 kPa working pressure.

.2 Float: solid material suitable for 121 degrees C working temperature.

2.2 PIPE LINE STRAINER

.1 NPS 1/2 to 2: bronze body to ASTM B62, solder end or screwed connections, Y pattern.

.2 NPS 2 1/2 to 12: cast steel body to ASTM A278M, Class 30, cast iron body to ASTM, Class 30 flanged connections.

.3 NPS 2 to 12: T type with ductile iron body to ASTM A536, malleable iron body to ASTM A47M, grooved ends.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel with 1.19 mm perforations.

.6 Working pressure: 860 kPa.

2.3 RELIEF VALVES

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

2.4 CIRCUIT SETTER (BALANCE VALVE)

.1 Provide bronze (copper alloy), ductile iron or cast iron with bronze or copper alloy disc, complete with pressure tappings, memory lock and insulation blocks.

2.5 AUTOMATIC FLOW RESTRICTOR (BALANCE VALVE)

.1 Automatic flow control valve complete with isolation and strainer, sized for design flow rate.

.2 Body: Forged brass or cast brass.

.3 Strainer: 20 mesh stainless steel filter screen complete with drain vale.

.4 Isolation: Ball valve with Teflon seats, refer to valve specifications.

.5 Provide manual air vents.

.6 Provide P/T test (gauge) ports.

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 follows directive.

.5 Check shop drawings for conformance of all tappings 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 radiation and as indicated.

3.3 AIR VENTS

.1 Install manual air vents at high points of systems unless noted otherwise.

.2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

.3 Construct manual air vent from short vertical section of 50 mm diameter pipe to form air chamber. Provide 3 mm brass needle valve at top of chamber. Provide U-bend copper tubing on discharge of valve to allow discharge to a 5 gallon pail.

.4 Use automatic float type at heating units and system high points not readily accessible for servicing.

.5 Where large air quantities can accumulate, provide enlarged air collection standpipes.

.6 For float type air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.

.7 Install isolation valves prior to all air vents.

3.4 PRESSURE SAFETY RELIEF VALVES

.1 Run discharge pipe to terminate above floor drain.

3.5 RELIEF VALVES

.1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.

.2 Drain relief valve to nearest floor drain.

.3 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one line vents several relief valves, cross sectional area shall equal sum of individual vent areas.

3.6 CIRCUIT SETTERS

.1 Provide on heating and cooling equipment to facilitate system balancing, as indicated on drawing, details and schematics.

3.7 FLOW RESTRICTORS

.1 Provide on heating equipment to facilitate system balancing, as indicated on drawings, details and schematics.

3.8 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping Systems, supplemented as specified herein.

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Copper piping valves and fittings for hydronic systems.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Welding Society (AWS)
  .1 ANSI/AWS A5.8/A5.8M-04, Specification Filler Metals for Brazing and Bronze Welding.

.2 American Society of Mechanical Engineers (ASME)
  .1 ANSI/ASME B16.4-98, Gray-Iron Threaded Fittings.
  .2 ANSI/ASME B16.15-1985(2004), Cast Bronze Threaded Fittings.
  .3 ANSI B16.18-2001, Cast Copper Alloy, Solder Joint Pressure Fittings.
  .4 ANSI/ASME B16.22-2001, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.

.3 American Society for Testing and Materials International (ASTM)
  .1 ASTM B32-04, Standard Specification for Solder Metal.
  .2 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
  .3 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
  .4 ASTM B88M-03, Standard Specification for Seamless Copper Water Tube Metric.
  .5 ASTM E202-04, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  .1 Material Safety Data Sheets (MSDS).

.5 Manufacturers Standardization Society (MSS)
  .1 MSS SP67-2002a, Butterfly Valves.
  .2 MSS SP70-1998, Cast Iron Gate Valves, Flanged and Threaded Ends.
  .3 MSS SP71-1997, Grey Iron Swing Check Valves, Flanged and Threaded Ends.
  .4 MSS SP80-2003, Bronze Gate, Globe, Angle and Check Valves.
  .5 MSS SP85-2002, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 QUALITY ASSURANCE

.1 Regulatory Requirements: ensure Work is performed in compliance with applicable Provincial /Territorial regulations.

2 Products

2.1 TUBING

.1 Type A hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

.1 Cast bronze threaded fittings: to ANSI/ASME B16.15.

.2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.

.3 Cast iron threaded fittings: to ANSI/ASME B16.4.

.4 Cast copper alloy solder joint pressure fittings: to ANSI B16.18.

2.3 FLANGES

.1 Brass or bronze: threaded.

.2 Cast iron: threaded.

.3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

.1 Solder, tin-antimony, 95:5: to ASTM B32.

.2 Silver solder BCUP: to ANSI/AWS A5.8.

.3 Brazing: as indicated.

2.5 VALVES

.1 Connections:
- .1 NPS 2 and smaller: ends for soldering.
- .2 NPS 2 1/2 and larger: flanged or grooved ends.

.2 Gate Valves Application: isolating equipment, control valves, pipelines:
- .1 NPS 2 and under:
  - .1 Mechanical Rooms: Class 125, rising stem split wedge disc, as specified Section 23 05 22 - Valves - Bronze.
  - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.

.3 Butterfly valves: application: isolating each section of multiple component equipment (eg. multi-section coils):
- .1 NPS 2 1/2 and over: lug type, grooved ends: as specified Section 23 05 17 - Pipe Welding.

.4 Globe valves: application: throttling, flow control, emergency bypass:
- .1 NPS 2 and under:
  - .1 Mechanical Rooms: with PFTE disc, as specified Section 23 05 22 - Valves - Bronze.
  - .2 Elsewhere: with composition disc, as specified Section 23 05 22 - Valves - Bronze.

.5 Balancing, for TAB:
.1 Sizes: calibrated balancing valves, as specified.
.2 NPS 2 and under:
.1 To match existing.

.6 Drain valves: gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.

.7 Swing check valves:
.1 NPS 2 and under:
.1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze.

.8 Silent check valves:
.1 NPS 2 and under:
.1 As specified Section 23 05 22 - Valves - Bronze.

.9 Ball valves:
.1 NPS 2 and under: as specified Section 23 05 22 - Valves - Bronze.

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 PIPING INSTALLATION

.1 Refer to Section 23 05 05 Installation of Pipework

.2 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.

.3 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 where ever practical.

.4 Slope piping in direction of drainage and for positive venting.

.5 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.

.6 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.

.7 Assemble piping using fittings manufactured to ANSI standards.

3.3 VALVE INSTALLATION

.1 Refer to Section 23 05 05 - Installation of Pipework.

.2 Install rising stem valves in upright position with stem above horizontal.

.3 Install butterfly valves on chilled water and condenser water lines only.

.4 Install gate, ball or butterfly valves at branch take-offs and to isolate each piece of equipment, and as indicated.

.5 Install globe valves for balancing and in by-pass around control valves as indicated.

.6 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

.7 Install ball valves for glycol service.

3.4 BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.5 AUTOMATIC CONTROL VALVES

.1 Install where indicated.

.2 Record flow or valve identification tag.

.3 Flow to be within 10% of specified value.

3.6 FLUSHING AND CLEANING

.1 Flush and clean in presence of Departmental Representative.

.2 Flush after pressure test for a minimum of 4h.

.3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8h.

.4 Refill system with clean water. Circulate for at least 4h. Clean out strainer screens/baskets regularly. Then drain.

.5 Refill system with clean water. Circulate for at least 2h. Clean out strainer screens/baskets regularly. Then drain.

.6 Drainage to include drain valves, dirt pockets, strainers, low points in system.

.7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.7 FILLING OF SYSTEM

.1 Refill system with clean water/glycol solution, adding water treatment to match existing.

3.8 FIELD QUALITY CONTROL

.1 Testing:
- .1 Test system in accordance with Section 23 05 02 - General Mechanical Provisions.
- .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

.2 Balancing:
- .1 Balance water systems to within plus or minus 5% of design output.

.3 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 Departmental Representative.

3.9 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.

END OF SECTION

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 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME).
- .1 ASME B16.1-98, Cast Iron Pipe Flanges and Flanged Fittings.
- .2 ASME B16.3-98, Malleable Iron Threaded Fittings.
- .3 ASME B16.5-03, Pipe Flanges and Flanged Fittings.
- .4 ASME B16.9-01, Factory-Made Wrought Buttwelding Fittings.
- .5 ASME B18.2.1-03, Square and Hex Bolts and Screws (Inch Series).
- .6 ASME B18.2.2-87(R1999), Square and Hex Nuts (Inch Series).

.2 American Society for Testing and Materials International, (ASTM).
- .1 ASTM A47/A47M-99, Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M-02, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- .3 ASTM A536-84(1999)e1, Standard Specification for Ductile Iron Castings.
- .4 ASTM B61-02, Standard Specification for Steam or Valve Bronze Castings.
- .5 ASTM B62-02, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .6 ASTM E202-00, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.

.3 American Water Works Association (AWWA).
- .1 AWWA C111-00, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).
- .1 CSA B242-M1980(R1998), Groove and Shoulder Type Mechanical Pipe Couplings.
- .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS).
- .1 MSS-SP-67-025, Butterfly Valves.
- .2 MSS-SP-70-98, Cast Iron Gate Valves, Flanged and Threaded Ends.
- .3 MSS-SP-71-97, Cast Iron Swing Check Valves Flanged and Threaded Ends.
- .4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.
- .5 MSS-SP-85-02, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

1.3 SUBMITTALS

.1 Submit shop drawings 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 and include following:
  - .1 Special servicing requirements.

2 Products

2.1 PIPE

.1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
.1 To NPS6.

2.2 PIPE JOINTS

.1 NPS2 and under: screwed fittings with PTFE tape.

.2 NPS2-1/2 and over: flanges to CAN/CSA W48.

.3 Roll grooved: standard coupling to CSA B242.

.4 Flanges: plain or raised face, slip-on weld neck to AWWA C111.

.5 Orifice flanges: slip-on raised face, 2100 kPa.

.6 Flange gaskets: to AWWA C111.

.7 Pipe thread: taper.

.8 Bolts and nuts: to ASME B18.2.1 and ASME B18.2.2.

.9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

.1 Screwed fittings: malleable iron, to ASME B16.3, Class 150.

.2 Pipe flanges and flanged fittings:
.1 Cast iron: to ASME B16.1, Class 125.
.2 Steel: to ASME B16.5.

.3 Butt-welding fittings: steel, to ASME B16.9.

.4 Unions: malleable iron, to ASTM A47/A47M and ASME B16.3.

.5 Fittings for roll grooved piping: malleable iron to ASTM A47/A47M, ductile iron to ASTM A536.

2.4 VALVES

.1 Connections:
.1 NPS2 and smaller: screwed ends.

.2 Gate valves: to MSS-SP-70. Application: Isolating equipment, control valves, pipelines:
.1 NPS2 and under:
.1 Mechanical Rooms: Class 125, rising stem, split wedge disc, as specified Section 23 05 22 - Valves - Bronze.
.2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.

.2 Globe valves: to MSS-SP-80, 85 Application: Throttling, flow control, emergency bypass.
.3 NPS2 and under:
.1 Mechanical Rooms: with PTFE disc, as specified Section 23 05 22 - Valves - Bronze.
.2 Elsewhere: Globe, with composition disc, as specified Section 23 05 22 - Valves - Bronze.

.3 Balancing, for TAB:
.1 Sizes: Calibrated balancing valves, as specified this section.
.2 NPS2 and under:
.1 Automatic flow control device where specified.
.2 Circuit setter where specified.

.4 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified Section 23 05 22 - Valves - Bronze.

.5 Swing check valves: to MSS-SP-71.
.1 NPS2 and under:
.1 Class 125, swing, with composition disc, as specified Section 23 05 22 - Valves - Bronze.

.6 Silent check valves:
.1 NPS2 and under:
.1 As specified Section 23 05 22 - Valves - Bronze.

.7 Ball valves:
.1 NPS2 and under: as specified Section 23 05 22 - Valves - Bronze.

3 Execution

3.1 PIPING INSTALLATION

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

3.2 BALANCING VALVES

.1 Install flow measuring stations and flow balancing valves as indicated.

.2 Remove handwheel after installation and when TAB is complete.

.3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.3 TESTING

.1 Test system in accordance with Section 23 05 02 - General Mechanical Provisions.

.2 For glycol systems, retest with propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.

3.4 BALANCING

.1 Balance water systems to within plus or minus 5% of design output.

.2 Refer to Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for applicable procedures.

3.5 PERFORMANCE VERIFICATION

.1 In accordance with Section 23 08 01 - Performance Verification of Mechanical Piping.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Materials and installation for copper tubing and fittings for refrigerant.

1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.22-01, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
- .2 ASME B16.24-02, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500.
- .3 ASME B16.26-88, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .4 ASME B31.5-01, Refrigeration Piping and Heat Transfer Components.

.2 American Society for Testing and Materials International (ASTM)
- .1 ASTM A307-04, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B280-03, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA International)
- .1 CSA B52-99, Mechanical Refrigeration Code.

.4 Environment Canada (EC)
- .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
- .1 Material Safety Data Sheets (MSDS).

1.3 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 for piping, fittings and equipment.
- .2 Submit WHMIS MSDS in accordance with Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.4 QUALITY ASSURANCE

.1 Comply with Provincial Regulations and Mechanical Refrigeration Codes.

.2 Pre-Installation Meeting:
- .1 Convene pre-installation meeting one week prior to beginning work of this Section and on-site installations in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Charts.
  - .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 Health and Safety:
- .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.5 START-UP AND TESTING

.1 Supply initial charge of refrigerant and oil for each refrigeration system. Losses of oil or refrigerant prior to acceptance of equipment or due to defects covered under guarantee shall be replaced. Supply to the Owner, one complete charge of lubricating oil in addition to that placed in the system.

.2 Charge the system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

.3 Shut-down system if initial start-up testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

.4 Provide cooling season start-up, winter season shut-down for first year of operation.

2 Products

2.1 TUBING

.1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
- .1 Hard copper: to ASTM B280, type ACR.
- .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

.2 Steel Pipe: ASTM A53, Schedule 40, black, forged steel welding type fittings, welded joints.

.3 Flexible Connectors: Corrugated stainless steel or bronze hose with single layer of exterior braiding, minimum 230 mm long with copper tube ends.

2.2 FITTINGS

.1 Service: design pressure 2070 kPa and temperature 121 degrees C.

.2 Brazed:
- .1 Fittings: wrought copper to ASME B16.22.
- .2 Joints: silver solder or copper-phosphorous, 95% Cu-5%P and non-corrosive flux.

.3 Flanged:
- .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
- .2 Gaskets: suitable for service.
- .3 Bolts, nuts and washers: to ASTM A307, heavy series.

.4 Flared:
- .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

.1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

.1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.

.2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.

2.5 LIQUID INDICATORS

.1 Moisture and Liquid indicators shall be double port type with copper or brass body, and flared or solder ends.

.2 To include sight glass, colour coded paper moisture indicator with removable element cartridge and plastic cap.

.3 Provide removable seal caps on each port to inspect refrigerant condition.

2.6 STRAINERS

.1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.

.2 Cartridge material and screen size shall be suitable for refrigerant and pipe material utilized in the system.

2.7 FILTER DRIERS

.1 Combination filter driers shall be angle type, with brass shell and incorporate a combined straining and drying material.

.2 Desiccant material shall be replaceable.

2.8 SOLENOID VALVES

.1 Solenoid valves shall have copper or brass body with flared or screwed ends.

.2 Coil assembly shall be replaceable.

.3 Valves shall incorporate a manually operated stem to serve as a bypass in case of coil failure.

2.9 EXPANSION VALVES

.1 Provide angle type or straight through expansion valves suitable for the refrigerant utilized in the system.

.2 Valves shall have brass body, internal or external equalizer, adjustable super-heat setting and be complete with capillary tube and remote sensing bulb.

2.10 CHARGING VALVES

.1 Provide general purpose type refrigerant charging valves with brass body, flared or solder ends and with removable valve core.

.2 Provide valve inlet with quick coupling connection for ease of charging.

2.11 FLEXIBLE CONNECTORS

.1 Flexible connectors shall consist of close pitch corrugated bronze hose with single layer of exterior braiding to provide additional strength and prevent elongation of corrugated section.

.2 Connectors shall be minimum 9" long and provided with bronze fittings to facilitate connection to equipment.

2.12 CHECK VALVES

.1 Globe Type: Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc.

.2 Straight Thru Type: Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat.

2.13 PRESSURE RELIEF VALVES

.1 Straight Thru or Angle Type: Brass body and disc, neoprene seat, factory sealed and ASME stamped.

2.14 RECEIVERS

.1 Internal Diameter 150 mm and Smaller: UL listed, steel, brazed with tappings for inlet, outlet, and pressure relief valve.

.2 Internal Diameter Over 150 mm: Welded steel, to ANSI ASME SEC 8D.

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 GENERAL

.1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5, Section 23 05 01 - Installation of Pipework.

3.3 BRAZING PROCEDURES

.1 Bleed inert gas into pipe during brazing.

.2 Remove valve internal parts, solenoid valve coils, sight glass.

.3 Do not apply heat near expansion valve and bulb.

3.4 PIPING INSTALLATION

.1 General:
- .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.

.2 Hot gas lines:
- .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
- .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.
- .3 Provide inverted deep trap at top of risers.
- .4 Provide double risers for compressors having capacity modulation.
  - .1 Large riser: install traps as specified.
  - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

3.5 PRESSURE AND LEAK TESTING

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

.3 Test Procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.6 DX EQUIPMENT START-UP AND TESTING

.1 Refrigeration equipment: Prepare system for start-up by having manufacturer's factory trained representative supervise testing, dehydration and charging of machine. Do start-up including co-ordination on start-up of condensers.

.2 Testing:

.1 Provide sufficient refrigerant, dry nitrogen and refrigeration oil for pressure and operational testing under manufacturer's supervision.

.2 Prior to testing ensure that system is complete. Protect relief valves during test procedure. After completion of test, reconnect and make good piping connections and leak test entire system.

3.7 AIR COOLED CONDENSING UNIT

.1 Check unit for damage before and after placement:

.1 Protect and cover exposed units to the elements during construction.

.2 Conform to installation drawings. Mount units on roof mounting frame.

3.8 LIQUID INDICATORS

.1 Provide full size liquid indicators in main liquid line leaving condenser. If receiver is used install in liquid line leaving receiver.

3.9 STRAINERS

.1 Provide full size strainer ahead of each automatic valve. Where multiple expansion valves with integral strainers are used, install single main liquid line strainer.

.2 On steel piping systems provide adequate strainer in suction line to remove scale and rust inherent in steel pipe.

.3 Provide shut-off valve on each side of strainer to facilitate maintenance.

3.10 FILTER-DRIERS

.1 Filter-driers may be used in systems instead of separate strainers and driers.

.2 Install with three valve bypass assembly to permit isolation for servicing.

3.11 SOLENOID VALVES

.1 Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

.2 Provide solenoid valves with manually operated stems.

3.12 EXPANSION VALVES

.1 Size expansion valves properly to avoid penalty of being undersized at full load and of being excessively oversized at partial load.

.2 Properly evaluate refrigerant pressure drop through system to determine the available pressure drop across the valve.

.3 Select valves for maximum load at design operating pressure and minimum 7.2 deg.C. of superheat.

.4 Locate remote expansion valve sensing bulb immediately after evaporator outlet on suction line.

3.13 CHARGING VALVES

.1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valve.

3.14 FLEXIBLE CONNECTORS

.1 In general install suction and hot gas piping connections to compressors with three directional changes for distance of minimum six pipe diameters before reaching point of support.

.2 Flexible connectors shall only be utilized at or near compressors where it is not physically possible to absorb vibration within piping configuration.

3.15 FIELD QUALITY CONTROL

.1 Site Tests/Inspection:
- .1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.

.3 Use copper lines of largest practical size to reduce evacuation time.

.4 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5Pa absolute and filled with dehydrated oil.

.5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
- .1 Twice to 14 Pa absolute and hold for 4 h.
- .2 Break vacuum with refrigerant to 14 kPa.
- .3 Final to 5 Pa absolute and hold for at least 12 h.
- .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
- .5 Submit test results to Departmental Representative.

.7 Charging:

.1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.

.2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.

.3 Re-purge charging line if refrigerant container is changed during charging process.

.8 Checks:

.1 Make checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report measurements Departmental Representative.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Materials and installation of low-pressure metallic ductwork, joints and accessories.
- .2 Sustainable requirements for construction and verification.

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 A480/A480M-03c, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .2 ASTM A635/A635M-02, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.
- .3 ASTM A653/A653M-03, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Department of Justice Canada (Jus).
- .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
- .1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).
- .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .2 NFPA 90B-02, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 NFPA 96-01, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.

.6 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.
- .3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).
- .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.3 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.

1.4 DEFINITIONS

.1 Low pressure/low velocity: static pressure in duct less than 498 Pa and velocities less than 10 meters/second.

.2 Medium pressure/high velocity: Static pressure in duct less than 996 Pa and velocities between 10 meters/second and 20 meters/second.

.3 High pressure/high velocity: Static pressure in ducts more than 996 Pa and velocities greater than 4000 fpm.

.4 Duct sizes: as shown on drawings are outside dimensions. For acoustically lined or internally insulated ducts, sizes shown are actual duct sizes and the insulation thickness has been accounted for.

1.5 QUALITY ASSURANCE

.1 Ductwork shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems, and NFPA No. 96, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapours from Commercial Cooking Equipment.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

2 Products

2.1 GENERAL

.1 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm, cross break for rigidity. Open corners are not acceptable.

.3 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.4 Where 1.5 time radius elbows are not possible and where rectangular elbows possible, use rectangular elbows and provide approved type air foil turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibre glass inside.

.5 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breath, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

.6 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.

2.2 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
Up to 500	B

.2 Seal classification:
- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant, tape, or combination thereof.
- .3 Class C: transverse joints and connections made air tight with gaskets, sealant, tape or combination thereof. Longitudinal seams unsealed.

2.3 SEALANT

.1 Oil resistant, water based, anti-microbial, anti-bacterial, ultra violet resistant, polymer type, flame resistant duct sealant.

.2 VOC content to be less than VOC limits of the State of California's South Coast Air Quality District Rule #1168. VOC content less than 30 g/L (less water and less exempt compounds) for sealing metal to metal contact.

.3 Sealant shall be cured for a minimum of 48 hours.

.4 Flame Spread Rating: 0 (zero).

.5 Smoke Spread Raring: 0 (zero).

2.4 TAPE

.1 Tape: polyvinyl treated, open weave fiberglass tape, 50 mm wide.

2.5 DUCT LEAKAGE

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

2.6 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.
- .1 Rectangular: standard radius with single thickness turning vanes. Centreline radius: 1.5 times width of duct.
- .2 Round: smooth radius. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:
- .1 To 400 mm: with single thickness Airfoil turning vanes.
- .2 Over 400 mm: with double thickness Airfoil turning vanes.

.4 Branches:
- .1 Rectangular main and branch: with radius on branch 1.5 times width of duct.
- .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: 15 degrees maximum included angle when increasing duct sizes.
- .2 Converging: 45 degrees maximum included angle downstream of equipment.
- .3 Diverging: 30 degrees maximum included angle upstream of equipment.

.6 Offsets:
.1 Full radiused elbows, as indicated.

.7 Obstruction deflectors: maintain full cross-sectional area.
.1 Maximum included angles: as for transitions.

2.7 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.

.2 Fire stopping material and installation must not distort duct.

2.8 FABRICATION

.1 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm cross break for rigidity. Open corners are not acceptable.

.2 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.3 Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centre line. Where not possible and where rectangular elbows possible and where rectangular elbows used, provide approved type air foil turning vanes. Where acoustical lining is provided, provide turning vanes or perforated metal type with fibreglass inside.

.4 Increase duct sizes gradually, not exceeding 15 degree divergence wherever possible. Maximum divergence upstream of equipment to be 30 degrees and 45 degrees convergence downstream.

.5 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breath, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

.6 Provide easements where low pressure ductwork conflicts with piping and structure where easements exceed 10% duct area, split into two ducts maintaining original duct area.

2.9 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.
.2 Hanger configuration: to SMACNA.

.3 Hangers: black steel angle with galvanized steel rods to following table:

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10

Duct Size	Angle Size	Rod Size
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

.4 Horizontal Duct on Wall Supports Minimum Sizes:
- .1 Up to 450 mm wide: 38 mm x 16 ga. or 25 x 25 x 3 mm at 2400 mm spacing.
- .2 460 to 1000 mm wide: 38 x 38 x 3 mm at 12 00 mm spacing.

.5 Vertical Duct on Wall Supports Minimum Sizes:
- .1 At 3000 mm spacing: Up to 600 mm wide: 38 mm x 16 ga. 610 to 900 mm wide: 25 x 25 x 3 mm. 90 to 1200 mm wide: 32 x 32 x 3 mm.

.6 Vertical Duct Floor Supports Minimum Sizes: Riveted or screwed to duct.
- .1 Up to 1500 mm wide: 38 x 38 x 3 mm. Over 1500 mm wide: 50 mm x 3 mm.

.7 Upper hanger attachments:
- .1 For concrete: manufactured concrete inserts.
- .2 For steel joist: manufactured joist clamp.
- .3 For steel beams: manufactured beam clamps.

2.10 WIRE ROPE SUSPENSION SYSTEMS

.1 Wire rope suspension systems shall be ULC, CSA and SMACNA approved and tested.

.2 Wire suspensions systems consist of a pre-formed wire rope sling with either a ferruled loop, permanently fixed threaded 1/4ins (or 3/8ins) stud, or permanently fixed nipple end with toggle, at one end or hook or eyelet. The end fixings and the wire must be of the same manufacturer. The system is secured and tensioned with a hanger self-locking grip at the other end.

.3 Only wire and or supports supplied and or approved, shall be used with the system.

.4 The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum Safe Working Load Limit (which incorporates a 5:1 safety factor). The correct specification of wire hanger required is determined using the following formula:

Weight per metre of object suspended (kg) x Distance between suspension points (m) = Weight loading per hanger suspension point (kg).

Table 1 Wire Hanger Safe Working Loads

Size	Working Load Limit (kg) Working Load Limit (lbs)
No. 1	0 - 10 kg 0 - 22 lbs
No. 2	10.5 - 45.5 kg 23 - 100 lbs
No. 3	46 - 91 kg 101 - 200 lbs
No. 4	95.5 - 225 kg 210 - 495 lbs
No. 5	225.5 - 325 kg 496 - 715 lbs

.5 Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations given in the manufacturer’s handbook.

.6 The Contractor shall select and use the correct length of wire rope required to support the service.

.7 No in-line joins shall be permitted in the rope.

3. Execution

3.1 GENERAL

.1 Do work in accordance with SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.
.1 Ensure diffuser is fully seated.

.3 Support risers in accordance with 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.

.6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

.7 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

3.2 INSTALLATION

.1 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cam with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.2 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.

.3 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.4 Connection diffusers or troffer boots to low pressure ducts with 1.5 m maximum length of straight flexible duct. Hold in place with caulking compound and strap or clamp. Do not use flexible duct to change direction.

.5 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

3.3 WIRE ROPE SUSPENSION SYSTEMS

.1 The wire hangers shall be fixed to the building structure in accordance with the standard practice and structural limitations.

.2 Loop end can be wrapped around purlins, beams, roof trusses and other accessible building features.

.3 Stud end can be fixed with suitable anchors into concrete ceilings and structures, metal decking and pressed metal brackets (using nuts).

.4 Toggle end can be fixed into profile roof cladding, light fittings and luminaries.

.5 Other wire rope systems can be fixed to an approved structure, as determined by the Departmental Representative.

.6 The wire hangers shall not be fixed to any other services, without the approval of the Departmental Representative.

.7 The free end of the wire rope should be threaded through one channel of the self-locking grip before being either passed around the object being suspended or connected to it, using a suitable fixing. The wire rope is then threaded back through the second channel in the grip until the required level is achieved.

.8 Adjust duct elevations as required to remain level and plumb, the weight of the suspended object must be independently supported while making adjustments.

.9 The wire rope must not be damaged, twisted or deformed in any way prior to, or during, installation. Any such ropes must be discarded and replaced.

.10 When installing wire hangers the angle between the ropes when exiting the grip must never exceed the manufacturer's recommendations and/or 60 degrees.

.11 Lubricants, paint or any other coating shall not be applied to the wire hanger as it may impair its performance.

.12 Wire hangers must be installed in accordance with the manufacturer's loading and installation instructions and all the manufacturer's recommendations.

3.4 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.5 SEALING AND TAPING

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

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

3.6 LEAKAGE TESTS

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

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.6 Complete test before performance insulation or concealment Work.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Materials and installation of high-pressure metallic ductwork, joints and accessories.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 American Society for Testing and Materials (ASTM).
  .1 ASTM A653/A653M-04a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process. (Metric).

.3 Department of Justice Canada (Jus).
  .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  .2 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  .1 Material Safety Data Sheets (MSDS).

.5 Sheet Metal Air Conditioning Contractors' National Association (SMACNA).
  .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 95 (Addendum No. 1, (1997).
  .2 SMACNA HVAC Air Duct Leakage Test Manual, 1st Edition 1985.
  .3 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Section 02 61 33 - Hazardous Materials for the following:
  .1 Sealants.
  .2 Tape.
  .3 Proprietary joints.
  .4 Fittings.

1.4 QUALITY ASSURANCE

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

1.5 DEFINITIONS

.1 Low pressure/low velocity: static pressure in duct less than 498 Pa and velocities less than 10 meters/second.

.2 Medium pressure/high velocity: Static pressure in duct less than 996 Pa and velocities between 10 meters/second and 20 meters/second.

.3 High pressure/high velocity: Static pressure in ducts more than 996 Pa and velocities greater than 4000 fpm.

.4 Duct sizes: as shown on drawings are outside dimensions. For acoustically lined or internally insulated ducts, sizes shown are actual duct sizes and the insulation thickness has been accounted for.

1.6 QUALITY ASSURANCE

.1 Ductwork shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems, and NFPA No. 96, Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapours from Commercial Cooking Equipment.

.2 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks.

1.7 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

.1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

2 Products

2.1 GENERAL

.1 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm, cross break for rigidity. Open corners are not acceptable.

.3 Lop metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.4 Where 1.5 time radius elbows are not possible and where rectangular elbows possible, use rectangular elbows and provide approved type air foil turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibre glass inside.

.5 Rigidly constructed metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breath, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled.

2.2 DUCTWORK

.1 Material:
- .1 Galvanized steel with Z90 designation zinc coating lock forming quality: to ASTM A653/A653M.
- .2 Thickness: to SMACNA.

.2 Construction - round and oval.
- .1 Ducts: factory fabricated, spiral wound, with matching fittings and specials to SMACNA.
- .2 Transverse joints up to 900 mm: slip type with tape and sealants.
- .3 Transverse joints over 900 mm: Vanstone.
- .4 Fittings:
  - .1 Elbows: smooth radius or five-piece (for 90 degrees), three-piece (for 45 degrees). Centreline radius: 1.5 x diameter.
  - .2 Branches: conical transition with conical branch at 45 degrees and 45 degrees elbow.

.3 Construction - rectangular:
- .1 Ducts: to SMACNA.
- .2 Transverse joints: welded or proprietary duct joints to SMACNA seal Class A.
- .3 Fittings:
  - .1 Elbows: smooth radius; centreline radius 1.5 x width of duct. No vanes.
  - .2 Branches: with conical branch at 45 degrees and 45 degrees elbow.

.4 Firestopping:
- .1 50 x 50 x 3 mm retaining angles around duct, on both sides of fire separation.
- .2 Firestopping material must not distort duct.

2.3 SEAL CLASSIFICATION

.1 Classification as follows:

Maximum Pressure Pa	SMACNA Seal Class
2500	A
1500	A
1000	A
750	A

.2 Seal classification:
- .1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant, gaskets, tape or combination thereof.
- .2 Class B: longitudinal seams, transverse joints and connections made airtight with gaskets, sealant, tape or combination thereof.

2.4 SEALANT

.1 Oil resistant, water based, anti-microbial, anti-bacterial, ultra violet resistant, polymer type, flame resistant duct sealant.

.2 VOC content to be less than VOC limits of the State of California's South Coast Air Quality District Rule #1168. VOC content less than 30 g/L (less water and less exempt compounds) for sealing metal to metal contact.

.3 Sealant shall be cured for at minimum of 48 hours.

.4 Flame spread Rating: 0 (zero).

.5 Smoke Spread Rating: 0 (zero).

2.5 TAPE

.1 Polyvinyl treated, open weave fibre glass, 50 mm wide.

2.6 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC air duct leakage test manual.

2.7 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping Equipment.
- .1 Band hangers: use on round and oval ducts up to 500 mm diameter, of same material as duct but next sheet metal thickness heavier than duct.
- .2 Trapeze hangers: ducts over 500 mm diameter or longest side, to SMACNA.
- .3 Hangers: steel angle with black steel rods to following table.

Duct Size (mm)	Angle Size (mm)	Rod Size (mm)
up to 750	25 x 25 x 3	6
751 to 1050	40 x 40 x 3	6
1051 to 1500	40 x 40 x 3	10
1501 to 2100	50 x 50 x 3	10
2101 to 2400	50 x 50 x 5	10
2401 and over	50 x 50 x 6	10

- .4 Upper hanger attachments:
  - .1 For concrete: manufactured concrete inserts.
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
    - .1 Mount to top cord.
  - .3 For steel beams: manufactured beam clamps:

2.8 WIRE ROPE SUSPENSION SYSTEMS

.1 Wire rope suspension systems shall be ULC, CSA and SMACNA approved and tested.

.2 Wire suspensions systems consist of a pre-formed wire rope sling with either a ferruled loop, permanently fixed threaded 1/4ins (or 3/8ins) stud, or permanently fixed nipple end with toggle, at one end or hook or eyelet. The end fixings and the wire must be of the same manufacturer. The system is secured and tensioned with a hanger self-locking grip at the other end.

.3 Only wire and or supports supplied and or approved, shall be used with the system.

.4 The contractor shall select the correct specification of wire hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum Safe Working Load Limit (which incorporates a 5:1 safety factor). The correct specification of wire hanger required is determined using the following formula:

Weight per metre of object suspended (kg) x Distance between suspension points (m) = Weight loading per hanger suspension point (kg).

Table 1 Wire Hanger Safe Working Loads

Size	Working Load Limit (kg) Working Load Limit (lbs)
No. 1	0 - 10 kg 0 - 22 lbs
No. 2	10.5 - 45.5 kg 23 - 100 lbs
No. 3	46 - 91 kg 101 - 200 lbs
No. 4	95.5 - 225 kg 210 - 495 lbs
No. 5	225.5 - 325 kg 496 - 715 lbs

i) Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations given in the manufacturer's handbook.

.5 The Contractor shall select and use the correct length of wire rope required to support the service.

.6 No in-line joins shall be permitted in the rope.

3 Execution

3.1 GENERAL

.1 Do work in accordance with SMACNA.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.
- .1 Insulate band hangers 100 mm beyond insulated duct.
- .2 Ensure diffuser is fully seated.

.3 Support risers in accordance with SMACNA.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Ensure installation of firestopping does not distort duct.

.6 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cam with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.7 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning.

.8 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.9 Connect terminal units to medium pressure ducts with 300 mm maximum length of flexible duct. Do not use flexible duct to change directions.

.10 At each point where ducts pass through partitions, the joints around the duct shall be sealed with non-combustible material.

3.2 HANGERS

.1 Band hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: as follows:

Duct Size (mm)	Spacing (mm)
to 1500	3000
1501 and over	2500

3.3 SEALING AND TAPING

.1 Apply sealant in accordance with SMACNA and to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturer's recommendations.

3.4 WIRE ROPE SUSPENSION SYSTEMS

.1 The wire hangers shall be fixed to the building structure in accordance with the standard practice and structural limitations.

.2 Loop end can be wrapped around purlins, beams, roof trusses and other accessible building features.

.3 Stud end can be fixed with suitable anchors into concrete ceilings and structures, metal decking and pressed metal brackets (using nuts).

.4 Toggle end can be fixed into profile roof cladding, light fittings and luminaries.

.5 Other wire rope systems can be fixed to an approved structure, as determined by the Departmental Representative.

.6 The wire hangers shall not be fixed to any other services, without the approval of the Departmental Representative.

.7 The free end of the wire rope should be threaded through one channel of the self-locking grip before being either passed around the object being suspended or connected to it, using a suitable fixing. The wire rope is then threaded back through the second channel in the grip until the required level is achieved.

.8 Adjust duct elevations as required to remain level and plumb, the weight of the suspended object must be independently supported while making adjustments.

.9 The wire rope must not be damaged, twisted or deformed in any way prior to, or during, installation. Any such ropes must be discarded and replaced.

.10 When installing wire hangers the angle between the ropes when exiting the grip must never exceed the manufacturer's recommendations and/or 60 degrees.

.11 Lubricants, paint or any other coating shall not be applied to the wire hanger as it may impair its performance.

.12 Wire hangers must be installed in accordance with the manufacturer's loading and installation instructions and all the manufacturer's recommendations.

3.5 LEAKAGE TESTS

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

.2 Perform leakage tests in sections.

.3 Perform trial leakage tests, as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial tests have been achieved.

.5 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.

.6 Complete tests before performing insulation or concealment Work.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
- .1 Material Safety Data Sheets (MSDS).

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

1.3 SUBMITTALS

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

.2 Product Data:
- .1 Submit manufacturer's printed product literature, specifications and data sheet. Indicate the following:
  - .1 Flexible connections.
  - .2 Duct access doors.
  - .3 Turning vanes.
  - .4 Instrument test ports.
- .2 Submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.

.3 Instructions: submit manufacturer's installation instructions.

2 Products

2.1 GENERAL

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

.2 Accessories shall meet MFPA 90a, Air Conditioning and Ventilating Systems.

2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame 1.2 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 1.0 kg/m^2.

.3 Attach to ducting and equipment by screws or bolts at no more than 150 mm intervals.

2.3 ACCESS DOORS IN DUCTS

.1 ULC labelled.

.2 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.

.3 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.

.4 Gaskets: neoprene.

.5 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.
- .6 300 x 300 mm glass viewing panels.
- .7 Fabricate in accordance with ASHRAE handbooks and SMACNA duct manuals.

2.4 TURNING VANES

.1 Factory or shop fabricated single thickness or double thickness, to recommendations of SMACNA and as indicated.

.2 Shall be airfoil type.

.3 Where acoustical lining is provided, provide turning vanes of perforated metal type with fibre glass inside.

2.5 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.

2.6 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.

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:
  - .1 600 x 600 mm for person size entry.
  - .2 900 x 900 mm for servicing entry.
  - .3 300 x 300 mm for viewing.
  - .4 As indicated.
- .2 Locations (before and after):
  - .1 Fire and smoke dampers (install at fire dampers).
  - .2 Control dampers.
  - .3 Devices requiring maintenance.
  - .4 Required by code.
  - .5 Reheat coils.
  - .6 Filters
  - .7 To facilitate cleaning of ductwork.
  - .8 Elsewhere 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 Ducted inlets to roof and wall exhausters.
    - .2 Inlets and outlets of other fan systems.
    - .3 Main and sub-main ducts.
    - .4 And as indicated.
  - .2 For temperature readings:
    - .1 At outside air intakes.
    - .2 In mixed air applications in locations as approved by Departmental Representative.
    - .3 At inlet and outlet of coils.
    - .4 Downstream of junctions of two converging air streams of different temperatures.
    - .5 And as indicated.

.4 Turning vanes:
- .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

.1 Perform cleaning operations as specified and in accordance with manufacturer's recommendations.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Balancing dampers for mechanical forced air ventilation and air conditioning systems.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCE

.1 Sheet Metal and Air Conditioning National Association (SMACNA).
- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible-1985.

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

1.3 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 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.

2 Products

2.1 GENERAL

.1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

.1 Fabricate from same material as duct but one sheet metal thickness heavier (minimum 16 gauge), with appropriate stiffening to avoid vibration.

.2 Double thickness construction to streamline shape.

.3 Control rod with locking device and position indicator.

.4 Rod configuration to prevent end from entering duct.

.5 Pivot: piano hinge.

.6 Folded leading edge.

.7 Size on basis of straight air volume proportioning.

2.3 SINGLE BLADE DAMPERS

.1 Fabricate from same material as duct, but one sheet metal thickness heavier (minimum 16 gauge). V-groove stiffened.

.2 Size and configuration to recommendations of SMACNA, except maximum height 100 mm.

.3 Locking quadrant with shaft extension to accommodate insulation thickness.

.4 Inside and outside nylon end bearings.

.5 Channel frame of same material as adjacent duct, complete with angle stop.

2.4 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 Bearings: self-lubricating nylon.

.5 Linkage: shaft extension with locking quadrant.

.6 Channel frame of same material as adjacent duct, complete with angle stop.

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 where indicated.

.2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.3 Locate balancing dampers in each low pressure branch duct, for supply, return and exhaust systems where branches are taken from longer duct.

.4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts. Where indicated on the drawings, a balancing damper is not required for runouts in non-accessible ceiling spaces provided a damper is specified on the register and diffuser.

.5 Dampers: vibration free.

.6 Ensure damper operators are observable and accessible. Provide access doors in ceilings/ walls where required.

.7 Provide 100 mm x 100 mm quick opening access doors for inspection at balancing dampers.

3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Tests to cover period of not less than seven (7) days and demonstrate that system is functioning as specified.

3.4 CLEANING

.1 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Fire and smoke dampers, and fire stop flaps.
- .2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)
- .1 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

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

.3 Underwriters Laboratories of Canada (ULC)
- .1 CAN4-S112-M1990, Fire Test of Fire Damper Assemblies.
- .2 CAN4-S112.2-M84, Standard Method of Fire Test of Ceiling Firestop Flap Assemblies.
- .3 ULC-S505-1974, Fusible Links for Fire Protection Service.

1.3 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 Indicate the following:
  - .1 Fire dampers.
  - .2 Smoke dampers.
  - .3 Fire stop flaps.
  - .4 Operators.
  - .5 Fusible links.
  - .6 Design details of break-away joints.

.2 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.

.3 Closeout Submittals:
- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Provide a Fire Damper Schedule identifying the following: damper tag, duct size, location, access door size, location.

1.4 QUALITY ASSURANCE

.1 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 6 fusible links of each type.

2 Products

2.1 FIRE DAMPERS

.1 Fire dampers: arrangement Type A, B and C, listed and bear label of ULC, UL, Warnock Hersey, meet requirements of authorities having jurisdiction. Fire damper assemblies fire tested in accordance with CAN4-S112. Fusible links on fire dampers shall be constructed to ULC Standard S505.

.2 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
- .1 Fire dampers: 1-1/2 hour fire rated unless otherwise indicated or required.
- .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: offset single damper, round or square; multi-blade hinged or interlocking type; roll door type; or guillotine type; sized to maintain full duct cross section as indicated.

.4 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

.5 50 x 50 x 3 mm retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.

.6 Equip fire dampers with steel sleeve and frame installed disruption ductwork (breakaway ductwork) to ensure damper operation is not impaired.

.7 Equip sleeves or frames with perimeter mounting angles attached on both sides of wall or floor opening. Construct ductwork in fire-rated floor-ceiling or roof-ceiling assembly systems with air ducts that pierce ceiling to conform with ULC.

.8 Design and construct dampers to not reduce duct or air transfer opening cross-sectional area.

.9 Dampers shall be installed so that the centerline of the damper depth or thickness is located in the centerline of the wall, partition of floor slab depth or thickness.

.10 Unless otherwise indicated, the installation details given in SMACNA and in manufacturer's instructions for fire dampers shall be followed.

.11 Springs to be corrosion resistant.

2.2 SMOKE DAMPERS

.1 Fabricate to NFPA 90A, UL 555, UL 555S, and as indicated.

.2 Provide factory sleeve and collar for each damper.

.3 Multiple Blade Dampers: Fabricate with 1.5 mm galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 3.2 x 12.7 mm plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 12.7 mm actuator shaft.

.4 Smoke Rating: Leakage Class III Smoke Damper in accordance with UL555S. A Class lll smoke damper leaks no more than 80 cubic feet per minute (2.27 m^3/min) at 4 in. wg. (1 kPa.) differential pressure

.5 Operators: UL listed and labelled Electric 120V, 60 Hz, two-position, fail close, externally mounted.

.6 Duct Smoke Detector: Factory mounted duct smoke detector with no minimum velocity requirement and powered from single point electrical connection to damper. Sensor to be photoelectronic type, as recommended for in duct application.

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 at locations shown, where ducts and outlets pass through fire rated components, and where required by authority having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.

.2 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.

.3 Maintain integrity of fire separation.

.4 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.

.5 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.6 Co-ordinate with installer of firestopping.

.7 Ensure access doors/panels, fusible links, damper operators are easily observed and accessible.

.8 Install break-away joints of approved design on each side of fire separation.

.9 Contractor to provide individually tag each and every fire damper and provide a fire damper schedule in the Operation and Maintenance manual showing tag, size, type and location.

.10 Contractor shall tag fire damper and access door with fire damper tag.

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.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Materials and installation of flexible ductwork, joints and accessories.
.2 Sustainable requirements for construction and verification.

1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.2 Department of Justice Canada (Jus).
  .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  .2 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  .1 Material Safety Data Sheets (MSDS).

.4 National Fire Protection Association (NFPA).
  .1 NFPA 90A-02, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  .2 NFPA 90B-02, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.

.5 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA).
  .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible, 95 (Addendum No.1, November 1997).
  .2 SMACNA IAQ Guideline for Occupied Buildings under Construction, 1st Edition 1995.

.6 Underwriters' Laboratories Inc. (UL).
  .1 UL 181-96, Standard for Factory-Made Air Ducts and Air Connectors.

.7 Underwriters' Laboratories of Canada (ULC).
  .1 CAN/ULC-S110-1986(R2001), Fire Tests for Air Ducts.

1.3 SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS in accordance with Section 02 61 33 - Hazardous Materials for the following:
  .1 Thermal properties.
  .2 Friction loss.
  .3 Acoustical loss.
  .4 Leakage.
  .5 Fire rating.

.3 Samples: submit samples with product data of different types of flexible duct being used in accordance with Section 01 33 00 - Submittal Procedures.

1.4 QUALITY ASSURANCE

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

1.5 INDOOR AIR QUALITY (IAQ) MANAGEMENT PLAN

.1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

2 Products

2.1 GENERAL

.1 Factory fabricated to CAN/ULC-S110.

.2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.

.3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 METALLIC – UNINSULATED

.1 Type 1: spiral wound flexible aluminum, as indicated.

.2 Performance:
  .1 Factory tested to 2.5 kPa without leakage.
  .2 Maximum relative pressure drop coefficient: 3.

2.3 METALLIC – INSULATED

.1 Type 2: spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate or aluminum jacket, as indicated.

.2 Performance:
  .1 Factory tested to 2.5 kPa without leakage.
  .2 Maximum relative pressure drop coefficient: 3.
  .3 Thermal loss/gain: 0.94 W/m^2. degrees C mean or RSI 1.06 (R6).

2.4 NON-METALLIC – UNINSULATED

.1 Type 3: non-collapsible, coated mineral base fabric type, mechanically bonded to, and helically supported by, external steel wire, or band as indicated.

.2 Performance:
  .1 Factory tested to 2.5 kPa without leakage.
  .2 Maximum relative pressure drop coefficient: 3.

2.5 NON-METALLIC – INSULATED

.1 Type 4: non-collapsible, coated mineral base fabric type mechanically bonded to, and helically supported by, external steel wire with factory applied, 37 mm thick flexible mineral fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate jacket, as indicated.

.2 Performance:
- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.

2.6 METALLIC ACOUSTIC INSULATED - LOW PRESSURE

.1 Type 5: Spiral wound, flexible perforated aluminum with factory applied 25 mm thick flexible mineral fibre thermal insulation and sleeved by aluminum foil/mylar laminate vapour barrier.

.2 Performance:
- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.

2.7 NON-METALLIC - ACOUSTIC INSULATED

.1 Type 7: non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate vapour barrier.

.2 Performance:
- .1 Factory tested to 2.5 kPa without leakage.
- .2 Maximum relative pressure drop coefficient: 3.

3 Execution

3.1 DUCT INSTALLATION

.1 Install in accordance with: SMACNA.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Tubular in-line fans.
.2 Fan accessories.
.3 Roof curbs.
.4 Motors and Drives.

1.2 SUBMITTALS

.1 Section 01 33 00: Procedures for submittals.

.2 Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

.3 Product Data:
  .1 Provide literature which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, and electrical characteristics and connection requirements.
  .2 Provide data of filter media, filter performance data, filter assembly, and filter frames.
  .3 Provide fan curves with specified operating point clearly plotted.
  .4 Submit sound power level data for both fan outlet and casing radiation at rated capacity.
  .5 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

1.3 SOURCE QUALITY CONTROL

.1 Fans used shall not decrease motor size, increase noise level, increase tip speed by more than 10 percent or increase inlet air velocity by more than 20 percent, from specified criteria; and capable of accommodating static pressure variations of plus or minus 10 percent.

1.4 OPERATION AND MAINTENANCE

.1 Submit operation and maintenance data to requirements of Section 01 78 00.

.2 Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

2 Products

2.1 TUBULAR INLINE FANS

.1 Wheel and Motor
  .1 Wheel shall be steel, non-overloading, centrifugal backward inclined, airfoil type. Blades shall be continuously welded to the backplate and deep spun inlet

shroud. Hubs shall be keyed and securely attached to the fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-96, Balance Quality and Vibration Levels for Fans.

.2 Motor shall be heavy duty type with permanently lubricated sealed ball bearings and furnished at the specified voltage, phase and enclosure.

.2 Construction

.1 The fan shall be of welded and bolted construction utilizing corrosion resistant fasteners.

.2 Housing shall be minimum 14 gauge steel with integral inlet and outlet flanges.

.3 Adjustable motor plate shall utilize threaded studs for positive belt tensioning.

.4 Extended lube lines shall be furnished for lubrication of fan bearings.

.5 Unit shall bear an engraved aluminum nameplate.

.6 Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

.7 Shafts: Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM. Shaft to have key-away and protectively coated with lubricating oil.

.8 Bearings shall be designed and tested specifically for use in air handling applications. Construction shall be heavy duty regreasable ball or roller type in a cast iron pillow block housing selected for a minimum L50 life in excess of 200,000 hours at maximum cataloged operating speed.

.9 Steel fan components shall be complete with an electrostatically applied, baked polyester powder coating. Each component shall be subject to a five stage environmentally friendly wash system, followed by a minimum 2 mil thick baked powder finish. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

.10 Belts shall be oil and heat resistant, non-static type. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

.11 Belt Guards: Fabricate to SMACNA Low Pressure Duct Construction Standards.

.3 Accessories

.1 Inlet/Outlet Screens: Galvanized steel welded grid.

.2 Access Doors: Shaped to conform to scroll with quick opening latches and gaskets.

.3 Scroll Drain: 15 mm steel pipe coupling welded to low point of fan scroll.

.4 Provide mounting base matched to fan.

.4 Certifications

.1 Fan shall be listed by Underwriters Laboratories (UL/cUL 705) for US and Canada. Fan shall bear the AMCA certified ratings seal for sound and air performance

3 Execution

3.1 PREPARATION

.1 Verify that electric power is available and of the correct characteristics (voltage and phase) prior to ordering pump.

3.2 INSTALLATION

.1 Install in accordance with manufacturer's instructions.

.2 Assemble high pressure packaged air units by bolting sections together. Isolate fan section with flexible duct connections.

.3 Install flexible connections between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 25 mm flex between ductwork and fan while running.

.4 Install fan restraining snubbers as indicated. Flexible connectors shall not be in tension while running.

.5 Pipe scroll drains to nearest floor drain.

.6 Provide access to adjustable blade axial fan wheels for varying blade angle setting. Adjust blades for varying range of volume and pressure.

.7 Provide floor mounted axial fans with reinforced legs and ceiling suspended units with support brackets bolted to casing flange.

.8 When fan inlet or outlet is exposed, provide safety screen.

.9 Install unit on vibration isolators with static deflection of 50 mm. For smaller fans, vibration isolators to be as recommended by manufacturer.

.10 Set roof mounted fans on metal, self flashing curbs 200 mm minimum above roof. Provide acoustic insulation on duct to below roof line and one fan inlet plenum and drip pan for collecting condensation.

.11 Provide exhaust fans with multi-blade, rattle free, back draft damper with felt lines blades edges, bird screen, disconnect switch and curb caps.

.12 Supply and install sheaves as necessary for final air balancing.

.13 Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Variable volume boxes.

1.2 REFERENCES

.1 American National Standards Institute (ANSI)
  .1 ANSI/AMCA 210-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  .2 ANSI/NFPA 90A-2002, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  .1 Material Safety Data Sheets (MSDS).

.3 International Organization of Standardization (ISO)
  .1 ISO 3741-2001, Acoustics-Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods for Reverberation Rooms.

.4 Underwriter's Laboratories (UL)
  .1 UL 181-2003, Factory-Made Air Ducts and Air Connectors.

1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:
  .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from certified ADC (Air Diffusion Council) testing agency signifying adherence to codes and standards.

1.4 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. Test data: to ANSI/AMCA 210.
    .1 Submit published test data on DIN (Direct Internal Noise), in accordance with ISO 3741 made by independent testing agency for 0, 2.5 and 6 m/s branch velocity or inlet velocity.
    .2 Sound power level with minimum inlet pressure of 1 kPa in accordance with ISO 3741 for 2nd through 7th octave band, also made by independent testing agency.
    .3 Pressure loss through silencer shall not exceed 60% of inlet velocity pressure maximum.

.2 Shop Drawings:
- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following:
  - .1 Capacity.
  - .2 Pressure drop.
  - .3 Noise rating.
  - .4 Leakage.

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

2 Products

2.1 MANUFACTURED UNITS

.1 Terminal units of the same type to be product of one manufacturer.

2.2 EXHAUST VARIABLE AIR VOLUME VALVE

.1 The system specified shall be based on electronically pressure independent environment airflow control valves used on the return/exhaust from the space. The EMCS shall be able to directly control through hardwire and/or integrate to the airflow control valve through on-board BACnet® interface.

.2 All control equipment required to fulfill this Specification shall be manufactured and provided by the airflow control valve equipment manufacturer.

.3 Unit shall consist of a compression section, two airflow control surfaces, factory-mounted digital vortex airflow measuring device factory-mounted standard speed electric actuator, integral access panel and integrated high performance closed-loop feedback controller with native BACnet.

.4 The compression section shall divide the airstream into at least two separate airstreams. Each airstream shall be approximately equal in size and the total open area shall be approximately 50% of the duct open area. The divided sections shall cause compression therefore creating a more laminar flow for better airflow measurement and turndown. The compression section shall be of an aerodynamic shape with a static regain section to insure minimal pressure drop. The valve shall not require any duct straight runs either upstream or downstream of the airflow valve to achieve required specified performance

.5 Airflow control valves shall be a linear type and shall operate with a minimum turndown ratio of 8 to 1. Accuracy of the airflow valve shall be 5% of reading in the 8 to 1 range of the damper.

.6 The airflow control valve shall be capable of being mounted in any position (360º mounting plane) in ductwork without the need for recalibration. It shall not be required to specify mounting plane when ordering valve. Airflow valves that must be ordered and mounted in either a vertical or horizontal plane will not be acceptable.

.7 Airflow control valves shall operate without linkages, springs, levers, or bearings, in the airstream due to the effect of exhaust air on those materials, and shall exhibit no deadband or hysteresis. Airflow control valves shall be provided as “fail last position”.

.8 All critical components of the airflow control valve shall be easily accessable from one side of the valve. All linkages shall be out of the airstream to avoid possible corrosion and loss of accuracy. Airflow valves that cannot be mounted with accessible control components (i.e. pivot arm/actuator) in the 4-8 o'clock orientation will not be acceptable.

.9 Airflow control valves shall be of a low pressure drop design for energy efficiency. Valves shall not require greater pressure drop than listed on equipment schedule. Airflow control valves that require higher pressures to operate shall not be acceptable.

.10 The airflow valve shall be complete with a digital vortex type airflow sensing device providing true airflow feedback for the system. Airflow valves using mechanical means for creating pressure independence will not be acceptable. Airflow valves incorporating pitot, orifice, venturi airflow or thermal airflow measurement will not be acceptable.

.11 Airflow measuring devices shall be of the Vortex Shedding type, capable of continuously monitoring the airflow volume of the duct served and electronically transmitting a signal linear to the airflow volume. Pitot, Orifice Venturi or Thermal Airflow sensors shall not be acceptable due to their susceptibility to coating and plugging of the sensors.

.12 Individual airflow sensors shall be of rugged construction, and shall not require special handling during installation. Sensors shall be mounted on support bars. Standard materials shall be manufactured of corrosion resistant plastic.

.13 Individual velocity sensors shall not be affected by dust, temperature, pressure, or humidity. The sensors shall be passive in nature, with no active parts within the air stream. The output from individual sensors shall be linear with respect to airflow velocity and shall be capable of sensing airflow in one direction only. The velocity sensors shall not require calibration.

.14 For another velocity sensing method to be considered equivalent to basis of design it must provide the basic requirements for linear electronic output, turndown, accuracy, materials of construction, and output signal. If differential pressure devices are to be considered (such as pitot and venturi), dual differential pressure transmitters, the span of the lower transmitter being one tenth the span of the higher, with an accuracy not less than +/- 0.5%, shall be utilized to provide the required turndown. Orifice type devices shall have a Beta ratio of 0.7 or less, and shall be installed in accordance with ASME MFC-3M guidelines for up and downstream conditions.

.15 Sensing methods employing thermal devices in the airstream shall not be acceptable due to their susceptibility to dust and dirt buildup in an exhaust airstream.

.16 The airflow sensors shall be easily accessable in the valve for inspection without removing valve from the duct. Airflow control valves provided without built in inspection ports will not be acceptable.

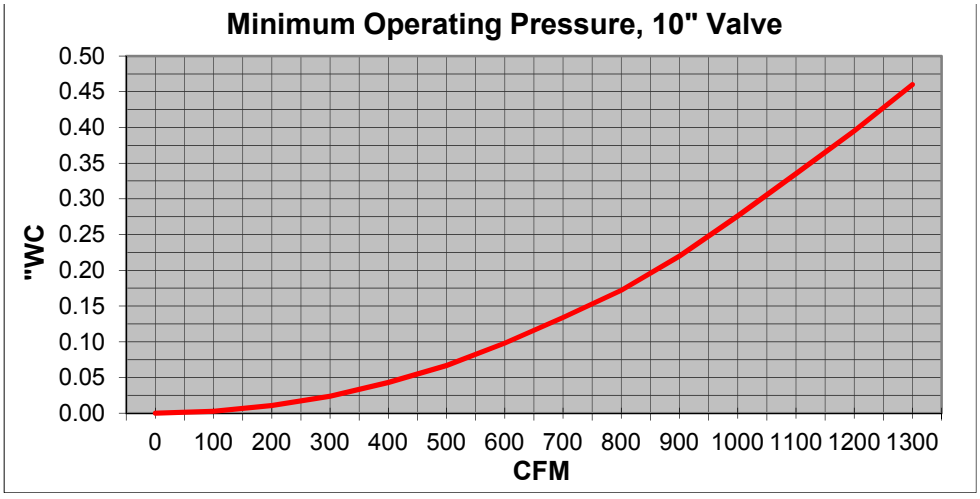
.17 Use of valve or damper position for calculation of airflow volume is not acceptable. Direct airflow measurements must be taken.

.18 Airflow control valves shall have an integral closed-loop feedback controller. Airflow measurement through the vortex airflow sensor shall send the digital signal to the controller which modulates the standard speed electric actuator to maintain desired airflow setpoint. The airflow setpoint shall have the capability of being provided through analog input, digital input, communications over BACnet MS/TP or AVC internal

program memory. Analog output signal shall be provided for airflow and alarm outputs must be provided to indicate abnormal airflow conditions. Coordinate with Division 25.

.19 Valve body material for non-corrosive service shall be 18 gauge aluminum for body and 16 gauge for blades.

.20 Minimizing energy consumption is of primary importance in the system design; therefore any airflow control valve considered for this project must be submitted with test data showing the Minimum Operating Pressure of the valve as tested in accordance with ANSI/ASHRAE STD 130-2008 Paragraph 5.3. The submitted test data must be in the form of an xy plot, with the y axis representing differential pressure measured across the fully opened valve and the x axis representing airflow volume measured through the fully opened valve. The test data for each size valve must include the entire published operating range of the valve. Standard literature for submitted valve must show both a curve and spreadsheet of minimum operating pressure drop versus CFM throughout its operating range. Any airflow control valve that does not publish this information will not be considered for this project. The example below is provided for an airflow control valve with a published minimum operating pressure of 0.3" wc and full scale range of 1,000 cfm.



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 manufacturers recommendations.

.2 Support independently of ductwork.

.3 Install with at 300 mm of flexible inlet ducting and minimum of four duct diameters of straight inlet duct, same size as inlet.

.4 Locate controls, dampers and access panels for easy access. Arrange for ceiling access to units: provide access doors or locate above easily removable ceiling components.

.5 Do not support from adjacent.

.6 Install each unit individually and from the 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.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Supply, return and exhaust grilles and registers, diffusers and linear grilles, for commercial and residential use.
- .2 Sustainable requirements for construction and verification.

1.2 SYSTEM DESCRIPTION

.1 Performance Requirements:
- .1 Catalogued or published ratings for manufactured items: obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency signifying adherence to Codes and Standards.

1.3 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 Indicate following:
  - .1 Capacity.
  - .2 Throw and terminal velocity.
  - .3 Noise criteria.
  - .4 Pressure drop.
  - .5 Neck velocity.

.2 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.

1.4 QUALITY ASSURANCE

.1 Air flow tests and sound level measurement shall be made in accordance with ANSI/ ASHRAE Standard 70.

.2 Manufacturer shall have published performance data.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

1.5 JOB CONDITIONS

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlet.

.2 Positions indicated are approximate only. Check location of outlets and make necessary adjustment in position to conform with Architectural features, symmetry, performance, and lighting arrangement.

2 Products

2.1 GENERAL

.1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity as indicated.

.2 Base air outlet application on space noise level, either by Noise Criteria (NC) curves or Room Criteria (RC) curves, as listed below:
- .1 Offices NC 30

.3 Frames:
- .1 Full perimeter gaskets.
- .2 Plaster frames for diffusers, located in plaster surface.
- .3 Concealed fasteners.

.4 Concealed manual volume control damper operators.

.5 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.6 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

.7 Refer to equipment schedule for specification of air outlets.

.8 Colour: as directed by Departmental Representative.

2.2 MANUFACTURED UNITS

.1 Grilles, registers and diffusers of same generic type, products of one manufacturer.

2.3 RETURN AND EXHAUST GRILLES AND REGISTERS

.1 Sidewall and ceiling exhaust grilles shall have streamlined blades, depth of which exceeds 20 mm spacing. Provide spring tension or other device to set blades. Provide units with horizontal face.

.2 Provide 25 mm narrow margin frame with countersunk screw holes.

.3 Fabricate of steel with 20 gauge minimum frames and 22 gauge minimum blades, steel and aluminum with 20 gauge minimum frame, or heavy aluminum extrusions.

.4 Provide exhaust grilles, with integral, gang-operated opposed blade dampers with removable key operator, operable from face, where indicated.

.5 Finish in factory baked enamel finish, colour by Departmental Representative.

2.4 GRID CORE RETURN AND EXHAUST GRILLES

.1 Fabricate fixed grilles of 13 mm x 13 mm x 13 mm louvres.

.2 Provide 32 mm margin frame with lay-in frame for suspended grid ceilings.

.3 Fabricate of aluminum.

.4 Provide exhaust grilles, where not individually connected to exhaust fans, with integral, gang-operated opposed blade dampers with removable key operator, operable from face, where indicated.

2.5 SQUARE PLAQUE DIFFUSER

.1 Diffuser shall consist of a precision formed back cone of one piece seamless construction which incorporates a round inlet collar of sufficient length for connecting rigid ductwork.

.2 Removable inner plaque assembly shall be incorporated that drops no more than 1/4" below the ceiling plane to assure proper air distribution performance.

.3 Sizes and mounting as detailed on drawings.

2.6 LINEAR SLOT DIFFUSER

.1 Linear slot diffuser complete with plenum assembly.

.2 Plenum assembly shall be constructed of zinc coated steel with 6 mm internal insulation.

.3 Plenum assembly shall have sloped shoulders for enhanced spread characteristics.

.4 Plenum assemblies shall be complete with side inlet.

.5 Sizes, slots and inlets as detailed on drawings.

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 manufacturer’s instructions.

.2 Install with oval head, stainless steel screws in countersunk holes where fastenings are visible.

.3 Bolt grilles, registers and diffusers, in place, where indicated.

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.

END OF SECTION

1 General

1.1 SECTION INCLUDES

.1 Refrigerant piping and connections.
.2 Refrigerant specialties: moisture and liquid indicators, valves, strainers, check valves, pressure relief valves, filter-driers, solenoid valves, expansion valves, receivers, flexible connections.
.3 Reciprocating compressors.
.4 Air cooled condensing units.
.5 Controls and control connections.

1.2 QUALITY ASSURANCE

.1 Manufacturer: Company specializing in manufacture of refrigeration system components with three years documented experience.
.2 Equipment shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment
.3 Equipment and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
.4 System Seasonal Energy Efficiency Ratio/Energy Efficiency Ratio (SEER/EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
.5 Units shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

1.3 SUBMITTALS

.1 Submit shop drawings to requirements of Section 01 33 00.

.2 Indicate general assembly of specialties, rated capacities, weights, accessories, electrical requirements, wiring diagrams (clearly indicate any and all field wiring requirements), dimensions, operating and shipping weights and loading, required clearances, and location and size of field connections. Include schematic layouts showing condenser, refrigeration compressors, cooling coils, refrigerant piping and accessories required for complete system.

.3 Submit design data indicating pipe sizing.

.4 Submit manufacturer's installation instructions under provisions of Section 01 33 00.

1.4 SUBMITTALS FOR INFORMATION

.1 Sections 01 33 00 and 01 78 10: Submission procedures.

.2 Manufacturer's Certificate: Certify that specified products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

.1 Section 01 33 00: Submission procedures.

1.6 PROJECT RECORD DOCUMENTS

.1 Submit documents to requirements of Section 01 78 10.

.2 Accurately record actual locations of equipment and refrigeration accessories on drawings.

1.7 OPERATION AND MAINTENANCE DATA

.1 Submit operation and maintenance data to requirements of Section 01 78 10.

.2 Include start-up instructions, maintenance data, parts lists, controls, and accessories.

1.8 WARRANTY

.1 Provide a 5 year warranty to Section 01 78 10 and CCDC 2 General Conditions.

.2 Warranty: Include coverage for refrigerant compressors and motors.

1.9 START-UP AND TESTING

.1 Supply initial charge of refrigerant and oil for each refrigeration system. Losses of oil or refrigerant prior to acceptance of equipment or due to defects covered under guarantee shall be replaced. Supply to the Owner, one complete charge of lubricating oil in addition to that placed in the system.

.2 Charge the system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

.3 Shut-down system if initial start-up testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

.4 Provide cooling season start-up, winter season shut-down for first year of operation.

2 Products

2.1 REFRIGERANT

.1 Refrigerant shall be an HFC (hydroflourocarbon) matched to system, refer to equipment schedule for basis of design.

2.2 HERMETIC COMPRESSORS

.1 Construct hermetic reciprocating compressors with positive oil lubrication system, internal pressure relief valve, suction service valve, discharge muffler, installed in welded steel shell.

.2 Provide automatic capacity reduction equipment consisting of electrically actuated suction valve unloaders with replaceable solenoid valves.

.3 Provide variable speed rpm compressor motor, suction gas cooled with two winding thermostats providing overheating protection, with starter.

.4 Provide crankcase heater, energized continuously.

2.3 SEMI-HERMETIC COMPRESSORS

.1 Construct semi-hermetic (serviceable hermetic) reciprocating compressors with reversible, positive displacement, oil pump lubrication system spring loaded heads and replaceable cylinder liners, mesh suction inlet screen, and discharge service valves.

.2 Provide automatic capacity reduction equipment consisting of suction valve unloaders operated by oil pressure.

.3 Provide variable speed compressor motor, suction gas cooled with solid state sensor and electronic winding overheating protection, with starter.

.4 Provide crankcase heater energized continuously.

2.4 COMPRESSOR CONTROLS

.1 On compressor, mount steel control panel, containing power and control wiring, moulded case disconnect switch, factory wired with single point power connection.

.2 Provide across-the-line starter, non-recycling compressor overload, starter relay, control power transformer or terminal for controls power, terminal strip for connection to interface equipment. Provide manual reset current overload protection.

.3 Provide the following devices on control panel face:
- .1 Compressor run light.
- .2 Start-stop switch.
- .3 Control power fuse or circuit breaker.
- .4 Demand limit switch.
- .5 Elapsed time meter.
- .6 Crankcase heater start-up switch and light.

.4 Provide high discharge pressure switch, low suction pressure switch, and oil pressure switch safety controls arranged so that operating any one will shut down machine and require manual reset.

.5 Provide the following operating controls:
- .1 Multi-step suction pressure controller which activates cylinder unloaders.
- .2 Five minute off timer prevents compressor from short cycling.
- .3 Part winding start timer.
- .4 Periodic pump-out timer to pump down on high suction refrigerant pressure.

.6 Provide pre-piped gage board with pressure gages for suction and discharge refrigerant pressures, and oil pressure.

2.5 WALK-IN FREEZER COOLING UNIT

.1 General Description:
- .1 Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
- .2 Condensing Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.

.3 Units shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
.4 Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
.5 Installation, Operation and Maintenance manual shall be supplied within the unit.
.6 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
.7 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
.8 System to serve freezer with control temperature of -29 Deg.C (-20 Deg.F).

.2 Condensing Unit Construction:
.1 Unit shall be completely factory assembled, piped, wired and shipped in one section.
.2 Unit shall be specifically designed for intended application, indoor unit.
.3 Condenser coils shall be mechanically protected from physical damage by painted galvanized steel louvers (wire grille) covering the full area of the coil.
.4 Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.
.5 Exterior paint finish shall be capable of withstanding at least 1,000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
.6 Unit shall include a fork-liftable base.

.3 Evaporator Construction:
.1 High efficiency and high strength fan guard
.2 Hinged doors for service access.
.3 Internally enhanced tubing.
.4 Uniform air flow.
.5 Hot gas defrost with hot gas loop pan heater.
.6 Electrical and header service compartments.
.7 Liquid line solenoid valve wire harness factory installed.
.8 Schrader valve on suction header.
.9 Positive slope, hinged drain pan.
.10 Central drain connections (approximate).
.11 Universal drain fitting.
.12 Large 3/4” ID (3/4” MPT) drain hole.
.13 Factory installed expansion valve, solenoid valve and room thermostat.
.14 EC motors with factory control from factory thermostat.

.4 Electrical:
.1 Unit shall be provided with standard power block for connecting power to the unit.
.2 Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
.3 Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal

.5 Refrigeration System

.1 Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.

.2 Compressors shall include stages of capacity control as indicated in equipment schedule.

.3 Unit shall include a variable speed EC motors on condenser for head pressure control.

.4 Compressors shall be mounted on base pan and can be accessed without affecting unit operation.

.5 Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

.6 Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided. Finished field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, (insulated hot gas bypass line), (insulated hot gas line) and insulated suction line.

.7 Each compressor shall be equipped with a 5 minute off, delay timer to prevent compressor short cycling.

.8 Although installed indoors, the unit shall be capable of stable cooling operation to a minimum of 55°F outdoor temperature.

.6 Air Cooled Condenser:

.1 Condenser fans shall be vertical (horizontal) discharge, axial flow, direct drive fans.

.2 Fan motor shall be weather protected, single phase, direct drive, and open drip proof with inherent overload protection.

.3 Coils shall be designed for use with the HFC refrigerant being utilized and constructed of copper tubes with aluminum (copper) fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

.4 Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

.5 Coils shall be helium leak tested.

.6 Provide expanded metal protective coil guard with lint screens.

.7 Controls

.1 Unit shall be provided with a terminal block for field installation of controls

.8 Factory Features

.1 Weatherproof electrical control box with compressor contactor and fused control circuit.

.2 High efficiency enhanced tube and fin condenser design.

.3 Receiver with fusible plug and liquid shut off valve

.4 Suction service valve

.5 Pre-formed copper tubing

.6 Liquid injection (low temp. models)

.7 Unit leak tested and shipped with helium holding charge.

.8 Fixed high pressure switch and adjustable low pressure control

.9 Receiver inlet and outlet shut off valve (2 fan units)

.10 Unit shall be provided with a terminal block for field installation of controls.

.11 Floating head pressure control system.

2.6 DEDICATED ROOM AIR CONDITIONING UNITS

.1 Integrated package: to CAN/CSA-C656.

.2 System type:
- .1 Air flow arrangement: as noted on equipment schedule
- .2 Cooling: direct expansion.
- .3 Condensing: air cooled.

.3 Cooling capacity, with fan heat extracted: based on environment of 22 degrees C dry bulb and 50% R.H. (plus or minus 1 degree C and 5% R.H.), with minimum supply air temperature of 14 degrees C.

.4 Unit capacity: as indicated:

.5 Cabinet:
- .1 Wall mounted, welded steel, unit construction, corrosion protected, 20 mm thick acoustic insulation, factory baked on external finish aesthetically compatible with typical computer and peripheral cabinets. Colour selected by Engineer.
- .2 Cabinet to house: cooling coil, fans, filters, unit environmental control system, motor starters or contactors and electrical disconnect switch.
- .3 Provide adequate access to components for servicing.
- .4 Corrosion protected welded structural steel floor stand having adjustable feet and locking device on corners, vibration isolators and compatible with raised floor system.
- .5 Fans: DWDI centrifugal, statically and dynamically balanced, direct drive, with self-aligning, permanently lubricated, 100,000 hours minimum life ball or roller bearings.
- .6 Fan Motors: Drip-proof permanently lubricated bearings for continuous duty, 40 degrees C maximum rise and variable pitch sheaves on belt driven systems.
- .7 Provide hail guards over fins.

.6 Compressors:
- .1 Semi hermetic type, minimum 2 required, with:
  - .1 Vibration isolators.
  - .2 Adjustable high and low pressure switches.
  - .3 Anti-slug device.
  - .4 Motor overload and over temperature protection pump down controls.
  - .5 Crank case heater.
  - .6 Compressor lead/lag switch.
  - .7 Refrigerant service valves.
  - .8 Capacity controls (variable speed compressor)

.7 Condenser:
- .1 Outdoor Air cooled: free standing, welded steel unit construction, corrosion protected.
  - .1 Circuited to provide separate refrigerant circuit for each compressor/evaporator combination.
  - .2 Aluminum fins, mechanically bonded to copper tubes, tested to 3.1 MPa.
  - .3 Propeller or centrifugal type fans. Direct drive.

.4 Electrical and control components housed in weather-tight access panels with electrical disconnect switch and control cable for control interconnection and designed for year round operation.
.5 Vibration isolation: providing at least 95% isolation efficiency.
.6 Capacity: to heat rejection capacity of 35 degrees C.
.7 Variable speed compressor for capacity control.

.8 Filters:
.1 Prefilters: Cleanable.
.2 Mounting: in corrosion resistant racks with service access.

.9 Refrigerant Piping, Valves, Fittings, and Accessories within unit
.1 To CSA B52.
.2 Include for each refrigerant circuit:
.1 Thermal expansion valve, external equalizing type.
.2 Combination filter-dryer.
.3 Solenoid valves.
.4 Liquid sight glass with moisture indicator.
.5 Suction line insulation: flexible elastomeric unicellar to ASTM C547, 12 mm minimum thickness.
.6 Liquid refrigerant receiver.

.10 Environmental Controls
.1 Solid state electronic control system.
.2 Front mounted operating panel with visual display.
.3 Panel to include following:
.1 Manual operation and adjustment:
.1 On-Off air conditioning system control.
.2 Room temperature set point, indicator and sensitivity adjustment controller.
.3 Alarm silencing switch for each alarm point.
.4 Alarm circuits test switch.
.2 Operational: Visual and Audible Alarm:
.1 Loss of air flow.
.2 Loss of liquid flow.
.3 High room temperature.
.4 Low room temperature.
.5 High head pressure.

.11 Refrigerant Charge
.1 Charge refrigerant system at factory, seal and test.
.2 Holding charge of refrigerant applied at factory.

.12 Capacity and Line Sizing
.1 Manufacturer and Mechanical Contractor shall ensure that system will operate at capacities indicated in equipment schedule despite distance from condensing units to indoor units and elevation change.
.2 Contractor shall ensure refrigerant liquid and suction lines are sized in accordance with manufacturer’s requirements for elevation change and distance between indoor and outdoor unit.

.3 Pipe distance is assumed to be 20m with an elevation change of 6m. Elevation change is included in pipe distance.

3 Execution

3.1 INSTALLATION

.1 Install equipment and specialties in accordance with manufacturer's instructions.

.2 Install piping to conserve building space and not interfere with use of space. Route piping in orderly manner, plumbing and parallel to building structure, and maintain gradient. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

.3 Provide non-conducting dielectric connections when joining dissimilar metals.

.4 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Provide clearance for installation of insulation and access to valves and fittings.

.5 Locate expansion valve sensing bulb immediately downstream of evaporator on suction line. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

.6 Install flexible connectors at right angles to axial movement of compressor.

.7 Provide for connection to electrical service.

.8 Install units on rubber-in-shear vibration isolation.

3.2 APPLICATION

.1 Provide line sized liquid indicators in main liquid line leaving condenser or in liquid line leaving receiver.

.2 Provide line size strainer upstream of each automatic valve. Where multiple expansion valves with integral strainers are used install single main liquid line strainer.

.3 On steel piping systems provide strainer in suction line.

.4 Provide shut-off valve on each side of strainer.

.5 Provide permanent filter-driers in low temperature systems.

.6 Provide replaceable cartridge filter-driers vertically in liquid line adjacent to receivers with three valve bypass assembly to permit isolation of driers for servicing.

.7 Provide replaceable cartridge filter driers, with three valve bypass assembly. Provide permanent filter driers for each solenoid valve.

.8 Provide solenoid valves in liquid line of systems operating with single pump-out or pump-down compressor control, in liquid line of single or multiple evaporator systems, and in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when the system shuts down.

.9 Provide refrigerant charging (packed angle) valve connections in liquid line between receiver shut-off valve and expansion valve.

.10 Utilize flexible connectors at or near compressors where within piping configuration does not absorb vibration.

3.3 FIELD QUALITY CONTROL

.1 Check unit for damage before and after placement.

.2 Protect and cover units during construction.

.3 Field inspection and testing will be performed under provisions of Section 01 70 00.

.4 Prepare system for start-up by having manufacturer's factory trained representative supervise testing, dehydration and charging of machine. Do start-up including co-ordination on start-up of condensers.

.5 Prior to testing ensure that system is complete. Protect relief valves during test procedure. After completion of test, reconnect and make good piping connections and leak test entire system.

.6 Provide sufficient refrigerant, dry nitrogen and refrigeration oil for pressure and operational testing under manufacturer's supervision. Replace losses of refrigerant and oil.

.7 Pressure test system with dry nitrogen to 1470 kPa. Perform final tests at 92 kPa vacuum and 1470 kPa using halide torch or electronic leak detector. Test to no leakage.

.8 Provide initial and cooling season start-up, and winter season shut down during first year of operation, including routine servicing and check out.

.9 Supply service of factory trained representative to supervise testing, dehydration and charging of machine, start-up, and instruction on operation and maintenance to Owner.

.10 Manufacturer's Field Services:

- .1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, at stages listed:
  - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
  - .2 Once during progress of Work at 60% complete.
  - .3 Upon completion of the Work, after cleaning is carried out.
- .4 Obtain reports, within 3 days of review, and submit, immediately, to departmental representative.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes.
- .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
  - .1 Start-up testing and verification of systems.
  - .2 Check out demonstration or proper operation of components.
  - .3 On-site operational tests.
  - .4 Cx Performance Tests and Verification.

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 DESIGN REQUIREMENTS

.1 Confirm with Departmental Representative that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01330 - Submittal Procedures.

.2 Final Report: submit report to Departmental 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 Departmental Representative before commissioning is started.

.4 Report to include complete point-to-point verification, including details on all corrective action taken and calibration.
.5 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
.6 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.
.7 Controls report to be submitted prior to implementation of witnessed Cx Performance Verification Tests.

1.5 CLOSEOUT SUBMITTALS

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

1.6 COMMISSIONING

.1 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative. Departmental Representative, at his discretion, may waive requirement for witnessing some of the Cx activities.

.2 Inform, and obtain approval from, Departmental 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.

.3 Perform Cs tests as required, refer to attached Performance Verification Forms. Correct deficiencies, and re-test. When EMCS passes test, perform test on required sampling of systems in presence of Departmental Representative until satisfactory performance is obtained.

.4 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

1.7 COMPLETION OF COMMISSIONING

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

1.8 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.

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.

3 Execution

3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Controls to perform point-to-point verification on entire EMCS (i.e. from screen to on-site device) and document on standard form. Form shall be reviewed and approved by Departmental Representative prior to conducting verification.

.3 Verify every sequence of operation. Identify every occasion where implemented sequence differs from specified and confirm acceptance of changes with Departmental Representative prior to witnessed Performance Verification Tests. Ensure that Performance Verification Tests are altered to suit such changes in squence.

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

.7 Retest required sampling in presence of Departmental Representative once system passes Controls Contractor’s verification.

3.2 SCHEDULE

.1 Contractor shall schedule start-up, check-out and Cx activities for each scheduled work area.

.2 Each scheduled work area shall be made fully functional before moving onto the next scheduled work area, including all Cx activities except the 30 day test.

.3 Refer to schedule for further information.

3.3 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.
- .1 General: consists of field tests of equipment just prior to installation.
- .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
- .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
.5 Additional instruments to include:
.1 DP transmitters.
.2 VAV supply duct SP transmitters.
.3 DP switches used for dirty filter indication and fan status.
.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.
.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.
.8 Contractor to mark instruments tracking within 0.5% in both directions as "approved for installation".
.9 Transmitters above 0.5% error will be rejected.
.10 DP switches to open and close within 2% of setpoint.
.11 Be prepared to re-test as Departmental Representative witnesses.

.2 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 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
.12 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 Departmental Representative. This document will be used in final startup testing.
.3 Final Startup Testing: Upon satisfactory completion of tests, perform system tests under direction of Departmental Representative and provide:
.1 Technical personnel capable of re-calibrating field hardware and modifying software.
.2 Detailed daily schedule showing items to be tested and personnel available.
.3 Departmental 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 Departmental 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 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
.2 Test to last at least 30 consecutive 24 hour days.
.3 Tests to include:
.1 Demonstration of correct operation of monitored and controlled points.
.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
.4 System will be accepted when:
.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
.2 Requirements of Contract have been met.
.5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
.6 Correct defects when they occur and before resuming tests.

.5 Departmental Representative to verify reported results.

3.4 ADJUSTING

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

3.5 DEMONSTRATION

.1 Demonstrate to Departmental 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.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.
- .2 Sustainable requirements for construction and verification.

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 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
- .1 ANSI/IEEE 260.1-1993, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
- .1 ASHRAE STD 135-R2001, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).
- .1 CAN/CSA-Z234.1-89(R1995), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).
- .1 CEA-709.1-B-2002, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).
- .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
- .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.

.7 Electrical and Electronic Manufacturers Association (EEMAC).
- .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.

.8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
- .1 Material Safety Data Sheets (MSDS).

.9 Transport Canada (TC).
- .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

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 25 character 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 ANSI/IEEE 260.1.
.2 Refer also to Section 25 05 54- EMCS: Identification.

1.5 SYSTEM DESCRIPTION

.1 Modify existing Energy Management and Control System (EMCS) to suit system revisions. Existing system consists of the following elements:

.1 Microcomputer based Building Controls (BC) interfacing directly with sensors, actuators and environmental delivery systems (ie: HVAC units, heat exchangers, VAV boxes, etc.).
.2 A two (2) wire peer communication network to allow data exchanger from BC to BC and BC's to the Central Building management computer.
.3 A personal computer (PC) based central and associated operator station and software functioning as the primary operator interface for the EMCS.
.4 Electric and electronic controls for all items indicated on drawings and described hereinafter including dampers, valves, panels and electrical installation.
.5 Incidental electric wiring to connect control system to interlocks, etc.
.6 Air flow measurement.
.7 Work station graphics for each and every sequence of operation.
.8 System to utilize TCP/IP communication and existing single mode fibre network from Central Heating Plant to Forensic Lab. Fibre and switches by Owner.
.9 Revise existing controls where possible. New controls to match existing.
.10 Update graphic to suit revisions.

.2 Work covered by Division 25 consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.
.2 Control devices required to implement sequence of operation.
.3 Existing OWS(s).
.4 Data communications equipment necessary to effect EMCS data transmission system in building.
.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 Design Requirements:
- .1 Design and provide conduit and wiring linking elements of system. As stated under 1.5.1.9.1, suitable existing wiring and conduit may be utilized in design and reused.
- .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
- .3 Location of controllers as reviewed by Departmental Representative prior to installation.
- .4 Provide utility power to EMCS where available.
- .5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements:
- .1 Provide English operator selectable access codes.
- .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
- .3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.
- .4 System manager software: include in English 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:
  - .1 Input and output commands and messages from operator-initiated functions, 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-definements).
  - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS.
  - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

1.6 COORDINATION

.1 All electrical low-voltage control wiring, including interlock wiring, required for the equipment supplied by Division 22, 23 and 25, except where otherwise noted, shall be supplied and installed by the Control Supplier. This includes all equipment being installed under the Chiller and Humidification Installation Package and all additional equipment being installed under this tender.

.2 All mechanical control wiring 50 volts or more shall be a minimum of #14 gauge wire. All mechanical control wiring less than 50 volts shall be minimum #18 gauge wire.

.3 All mechanical control wiring installed by the control supplier shall conform with the requirements of the local electrical authority and the specifications Division 26 Electrical.

.4 Electrical Contractor: Electrical shall provide the following:
- .1 All power wiring to equipment.
- .2 Existing 15 amp, 120V/60/1 phase fused power supply to each DDC control panel.
- .3 Electrical Contractor shall be responsible for wiring of inline control devices on 120 Vac as indicated on drawings.

1.7 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

.2 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 in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
- .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental 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 Existing devices intended for re-use: submit test report.

1.8 QUALITY ASSURANCE

.1 Have local office within Province staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,

.2 Have access to local supplies of essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.3 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

1.9 EXISTING CONDITIONS - CONTROL COMPONENTS

.1 Utilize existing control wiring and conduit where possible.

.2 Inspect and test existing devices intended for re-use within 30 days of award of contract, and prior to installation of new devices.
- .1 Furnish test report within 40 days of award of contract listing each component to be re-used and indicating whether it is in good order or requires repair.
- .2 Failure to produce test report will constitute acceptance of existing devices by Contractor.

.3 Non-functioning items:
- .1 Provide with report specification sheets or written functional requirements to support findings.
- .2 Departmental Representative will repair or replace existing items judged defective yet deemed necessary for EMCS.

.4 Submit written request for permission to disconnect controls and to obtain equipment downtime before proceeding with Work.

.5 Assume responsibility for controls to be incorporated into EMCS after written receipt of approval from Departmental Representative.
- .1 Be responsible for items repaired or replaced by Departmental Representative.
- .2 Be responsible for repair costs due to negligence or abuse of equipment.
- .3 Responsibility for existing devices terminates upon final acceptance of EMCS.

.6 Remove existing controls not re-used or not required. Place in approved storage for disposition as directed.

.7 The Contractor shall allow for the disconnection, relocation and rewiring of the following devices. This work is based on having to relocate the existing control panels the devices are hung in. It is assumed that the control devices affected will be relocated from the existing control panels to the associated terminal equipment.
- .1 Relocate and rewire the controllers for five (5) existing Supply Air Valves.
- .2 Relocate and rewire the controllers for five (5) existing Exhaust Air Valves.

2 Products

2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 ASHRAE STD 135.

.2 Complete list of equipment and materials to be used on project and forming part of 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.

3 Execution

3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

3.2 PAINTING

.1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:
- .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
- .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.
- .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
- .4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

1.2 DEFINITIONS

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

1.3 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.

.1 Location of local office.
.2 Description and location of installing and servicing technical staff.
.3 Location and qualifications of programming design and programming support staff.
.4 List of spare parts.
.5 Location of spare parts stock.
.6 Names of sub-contractors and site-specific key personnel.
.7 Sketch of site-specific system architecture.
.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
.9 Descriptive brochures.
.10 Sample CDL and graphics (systems schematics).
.11 Response time for each type of command and report.
.12 Item-by-item statement of compliance.
.13 Proof of demonstrated ability of system to communicate utilizing Proprietary Communications Protocol, BACnet or Lontalk.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 30 working days after tender closing and before contract award, for review by Departmental Representative.

.3 Shop Drawings to consist of 10 hard copies of design documents, shop drawings, product data and software.

.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

1.5 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:
- .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
- .2 Detailed system architecture showing all points associated with each controller including, signal levels, pressures where new EMCS ties into existing control equipment.
- .3 Spare point capacity of each controller by number and type.
- .4 Controller locations.
- .5 Auxiliary control cabinet locations.
- .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
- .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
- .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
- .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

1.6 DETAIL SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:
- .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
- .2 Wiring diagrams.
- .3 Piping diagrams and hook-ups.
- .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
- .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Associated field wiring schematics, schedules and terminations.
  - .4 Complete Point Name Lists.
  - .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
  - .6 Software and programming details associated with each point.
  - .7 Manufacturer's recommended installation instructions and procedures.
  - .8 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.
.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
.9 Listing and example of specified reports.
.10 Listing of time of day schedules.
.11 Type and size of memory with statement of spare memory capacity.
.12 Full description of software programs provided.
.13 Sample of "Operating Instructions Manual" to be used for training purposes.
.14 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

1.7 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:
.1 Undertake functional review of preliminary design documents, resolve inconsistencies.
.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
.3 Review interface requirements of materials supplied by others.
.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes.
  .1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
  .1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.4 SYSTEM DESCRIPTION

.1 Language Operating Requirements: provide identification for control items in English.

1.5 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

2 Products

2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3 mm thick, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain or plastic tie.

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name, point type, point address, associated controller, and description of service.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by lamicoids using point identifier.

.2 Location: on sensor cover.

.3 Letter size: to suit, clearly legible.

2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS".

2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint.

3 Execution

3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

3.2 EXISTING PANELS

.1 Correct existing nameplates and legends to reflect changes made during Work.

.2 Label all existing to specified standard.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes.
- .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

.2 References.
- .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
- .2 Canadian Standards Association (CSA International).
  - .1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

1.2 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

1.3 SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.

.3 Submit detailed inspection reports to Departmental Representative.

.4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
- .1 Point name and location.
- .2 Device type and range.
- .3 Measured value.
- .4 System displayed value.
- .5 Calibration detail
- .6 Indication if adjustment required,
- .7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
- .1 Maintain records and logs of each maintenance task on site.
- .2 Organize cumulative records for each major component and for entire EMCS chronologically.
- .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:
- .1 Initiate service calls when EMCS is not functioning correctly.
- .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
- .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
- .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
- .5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:
- .1 Serial number identifying component involved.
- .2 Location, date and time call received.
- .3 Nature of trouble.
- .4 Names of personnel assigned.
- .5 Instructions of work to be done.
- .6 Amount and nature of materials used.
- .7 Time and date work started.
- .8 Time and date of completion.

.5 Provide system modifications in writing.
- .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

.6 Back-up software.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform as minimum two major inspections (more often if required by manufacturer) per year; one at start of heating season and one at start of cooling season. Provide detailed written report to Departmental Representative as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
- .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
- .2 Check and Calibrate each field input/output device in accordance with Canada Labour Code - Part I and CSA Z204.
- .3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:
- .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
- .2 Check equipment cooling fans as required.
- .3 Review system performance with Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:
- .1 Minor inspection.
- .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
- .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
- .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
- .5 Run system software diagnostics as required.
- .6 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
  - .1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
- .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).
- .1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
- .2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
- .1 IEEE Std 802.3™-2002, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
- .1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1 General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.
- .2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).
- .1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-568, CSA T530, TIA/EIA-569-A and TBITS 6.9.
- .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
- .2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:
- .1 EMCS-LAN.
- .2 Network interface cards.

.3 Network management hardware and software.
.4 Network components necessary for complete network.
.5 Connections to Owner supplied single mode fibre using TCP/IP - ethernet.

1.5 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).
.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.
.2 EMCS-LAN to: BacNet.
.3 Each EMCS-LAN to be capable of supporting at least 50 devices.
.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.
.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.
.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.
.1 Network medium (inside building): shielded twisted cable, or fibre optic cable compatible with network protocol to be used within buildings.
.2 Network medium (from building to central Heating Plant): Utilize Owner supplied single mode fibre and TCP/IP communication.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
- .1 Materials and installation for building automation controllers including:
  - .1 Master Control Unit (MCU).
  - .2 Local Control Unit (LCU).
  - .3 Equipment Control Unit (ECU).
  - .4 Terminal Control Unit (TCU).

1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
- .1 ASHRAE 2003, Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).
- .1 C22.2 No.205-M1983(R1999), Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).
- .1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
- .1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 DEFINITIONS

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

1.4 SYSTEM DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided to support building systems and associated sequence(s) of operations as detailed in these specifications.
- .1 Provide sufficient controllers to meet intents and requirements of this section.
- .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.
- .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
- .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.
- .3 Capable of interfacing with operator interface device.
- .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
  - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

1.5 DESIGN REQUIREMENTS

.1 To include:
- .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
- .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
- .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
- .4 Control of systems as described in sequence of operations.
- .5 Execution of optimization routines as listed in this section.

.2 Field Termination and Interface Devices:
- .1 To: CSA C22.2 No.205.
- .2 Electronically interface sensors and control devices to processor unit.
- .3 Include, but not be limited to, following:
  - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
  - .2 Power supplies for operation of logics devices and associated field equipment.
  - .3 Lockable wall cabinet.
  - .4 Required communications equipment and wiring (if remote units).
  - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
  - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
  - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
- .4 AI interface equipment to:
  - .1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.
  - .2 Provide for following input signal types and ranges:
    - .1 4 - 20 mA;
    - .2 0 - 10 V DC;
    - .3 100/1000 ohm RTD input.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
  - .4 Have common mode signal rejection greater than 60 dB to 60 Hz.
  - .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 4 - 20 mA.
    - .2 0 - 10 V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:
- .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 24 V AC.
- .2 Switch up to 5 amps at 220 V AC using optional interface relay.

.3 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20% to 90% non-condensing RH.

.4 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
- .1 Provide for conduit entrance from top, bottom or sides of panel.
- .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
- .3 Mounting details as approved by Departmental Representative for ceiling mounting.

.5 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.6 Provide surge and low voltage protection for interconnecting wiring connections.

1.6 SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
- .1 Submit product data sheets for each product item proposed for this project.

1.7 MAINTENANCE PROCEDURES

.1 Provide manufacturers recommended maintenance procedures for insertion into Manuals.

2 Products

2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
- .1 MCU must support Proprietary Protocol, BACnet.

.3 MCU local I/O capacity as follows:
- .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
- .2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU).
- .1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.
- .2 CPU idle time to be more than 30% when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
  .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
  .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

.5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.

.3 Display simultaneously minimum of 16 point identifiersto allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.

.4 Functions to include, but not be limited to, following:
  .1 Start and stop points.
  .2 Modify setpoints.
  .3 Modify PID loop parameters.
  .4 Override PID control.
  .5 Change time/date.
  .6 Add/modify/start/stop weekly scheduling.
  .7 Add/modify setpoint weekly scheduling.
  .8 Enter temporary override schedules.
  .9 Define holiday schedules.
  .10 View analog limits.
  .11 Enter/modify analog warning limits.
  .12 Enter/modify analog alarm limits.
  .13 Enter/modify analog differentials.

.5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
- .1 Include minimum 2 interface ports for connection of local computer terminal.
- .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
- .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
- .4 Include power supplies for operation of LCU and associated field equipment.
- .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
- .6 Provide conveniently located screw type or spade lug terminals for field wiring.

2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
- .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

2.4 SOFTWARE

.1 General.
- .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
- .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
- .3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.
- .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.
- .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.
- .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
- .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

.4 Operator Terminal interface.
- .1 Operating and control functions include:
  - .1 Multi-level password access protection to allow user/manager to limit workstation control.
  - .2 Alarm management: processing and messages.
  - .3 Operator commands.
  - .4 Reports.
  - .5 Displays.
  - .6 Point identification.

.5 Pseudo or calculated points.
- .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
- .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):
- .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
- .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
- .3 Perform changes to CDL on-line.
- .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
- .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
- .6 MCU to be able to perform following pre-tested control algorithms:
  - .1 Two position control.
  - .2 Proportional Integral and Derivative (PID) control.
- .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
- .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and

analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:

.1 Time of day scheduling (Occupied and Unoccupied).
.2 Calendar based scheduling.
.3 Holiday scheduling.
.4 Temporary schedule overrides.
.5 Optimal start stop.
.6 Night setback control.
.7 Differential Enthalpy (economizer) switchover.
.8 Fan speed/flow rate control..

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times pump is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.
- .1 Display analog values digitally to 1 place of decimals with negative sign as required.
- .2 Update displayed analog values and status when new values received.
- .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
- .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

3 Execution

3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as indicated and as directed by Departmental Representative.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

1 General

1.1 SUMMARY

.1 Section Includes:
  .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, meters, switches, transducers, dampers, damper operators, valves, valve actuators, and low voltage current transformers.

1.2 REFERENCES

.1 American National Standards Institute (ANSI).
  .1 ANSI C12.7-1993(R1999), Requirements for Watthour Meter Sockets.
  .2 ANSI/IEEE C57.13-1993, Standard Requirements for Instrument Transformers.
.2 American Society for Testing and Materials International, (ASTM).
  .1 ASTM B148-97(03), Standard Specification for Aluminum-Bronze Sand Castings.
.3 National Electrical Manufacturer's Association (NEMA).
  .1 NEMA 250-03, Enclosures for Electrical Equipment (1000 Volts Maximum).
.4 Air Movement and Control Association, Inc. (AMCA).
  .1 AMCA Standard 500-D-98, Laboratory Method of Testing Dampers For Rating.
.5 Canadian Standards Association (CSA International).
  .1 CSA-C22.1-02, Canadian Electrical Code, Part 1 (19th Edition), Safety Standard for Electrical Installations.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.
  .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:
  .1 Submit manufacturer's installation instructions for specified equipment and devices.

1.5 EXISTING CONDITIONS

.1 Cutting and Patching: in accordance with Section 01 73 03 - Execution Requirements supplemented as specified herein.

.2 Repair surfaces damaged during execution of Work.

.3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

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, assembly.

.3 Operating conditions: 0 - 32 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 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity and 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 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.
- .2 Sensing element: hermetically sealed.
- .3 Stem and tip construction: copper or type 304 stainless steel.
- .4 Time constant response: less than 3 seconds to temperature change of 10 deg.C.
- .5 Immersion wells: NPS 1/2, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length as indicated.

.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.
  - .3 Button for occupancy override to switch to occupied mode outside occupied hours of operation for EMCS controlled period of time.
  - .4 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit and/or contractor supplied palm compatible handheld device for access to zone bus.
  - .5 Integral thermistor sensing element 10,000 ohm at 24 degrees.
  - .6 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
  - .7 Stability 0.02 degrees C drift per year.
  - .8 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 or as indicated.
- .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 Use existing.

2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:
- .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.
- .2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees 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 or 1000 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 degrees 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 degrees C to plus 50 degrees C, plus or minus 0.5 degrees C.
  - .2 0 to 100 degrees C, plus or minus 0.5 degrees C.
  - .3 0 to 50 degrees C, plus or minus 0.25 degrees C.
  - .4 0 to 25 degrees C, plus or minus 0.1 degrees C.
  - .5 10 to 35 degrees C, plus or minus 0.25 degrees C.

2.4 PRESSURE TRANSDUCERS

.1 Requirements:
- .1 Combined sensor and transmitter measuring pressure.
  - .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 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.
- .6 Over-pressure input protection to at least twice rated input pressure.
- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus 1% of Full Scale.

2.5 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.

2.6 STATIC PRESSURE SENSORS

.1 Requirements:
- .1 Multipoint element with self-averaging manifold.
  - .1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).
- .2 Accuracy: plus or minus 1 % of actual duct static pressure.

2.7 STATIC PRESSURE TRANSMITTERS

.1 Requirements:
- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .2 Calibrated span: not to exceed 150 % of duct static pressure at maximum flow.
- .3 Accuracy: 0.4% of span.
- .4 Repeatability: within 0.5 % of output.
- .5 Linearity: within 1.5 % of span.
- .6 Deadband or hysteresis: 0.1% of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

2.8 VELOCITY PRESSURE SENSORS

.1 Requirements:
- .1 Multipoint static and total pressure sensing element with self-averaging manifold with integral air equalizer and straightener section.
- .2 Maximum pressure loss: 37 Pa at 1000 m/s.
- .3 Accuracy: plus or minus 1 % of actual duct velocity.

2.9 VELOCITY PRESSURE TRANSMITTERS

.1 Requirements:
- .1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.
- .2 Calibrated span: not to exceed 125% of duct velocity pressure at maximum flow.
- .3 Accuracy: 0.4 % of span.
- .4 Repeatability: within 0.1 % of output.
- .5 Linearity: within 0.5 % of span.
- .6 Deadband or hysteresis: 0.1% of span.
- .7 External exposed zero and span adjustment.
- .8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

2.10 ELECTROMECHANICAL 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

2.11 SOLID STATE RELAYS

.1 General:
- .1 Relays to be socket or rail mounted.
- .2 Relays to have LED Indicator
- .3 Input and output Barrier Strips to accept 14 to 28 AWG wire.
- .4 Operating temperature range to be -20 degrees C to 70 degrees C.
- .5 Relays to be CSA Certified.
- .6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.
- .7 Operational frequency range, 45 to 65 HZ.

.2 Input:
- .1 Control voltage, 3 to 32 VDC.
- .2 Drop out voltage, 1.2 VDC.
- .3 Maximum input current to match AO (Analog Output) board.

.3 Output.
- .1 AC or DC Output Model to suit application.

2.12 CONTROL DAMPERS

.1 Reuse existing dampers.

2.13 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.
- .7 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

2.14 CONTROL VALVES

.1 Body: globe style, characterized ball.
- .1 Flow characteristic as indicated on control valve schedule: linear, equal percentage.
- .2 Flow factor (KV) to be based on 15% of total system pressure drop but not to exceed 10' of head across valve.
- .3 Normally open or normally closed, as indicated.
- .4 Two or three port, as indicated.
- .5 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
- .6 Packing easily replaceable.

.7 Stem, stainless steel.
.8 Plug and seat, stainless steel, brass.
.9 Disc, replaceable, material to suit application.
.10 NPS 2 and under:
  .1 Screwed National Pipe Thread (NPT) tapered female connections.
  .2 Valves to ANSI Class 250, valves to bear ANSI mark.
  .3 Rangeability 50:1 minimum.
.11 NPS 2½ and larger:
  .1 Flanged connections.
  .2 Valves to ANSI Class 250 as indicated, valves to bear ANSI mark.
  .3 Rangeability 100:1 minimum.

2.15 ELECTRONIC / ELECTRIC VALVE ACTUATORS

.1 Requirements:
  .1 Construction: steel, cast iron, aluminum.
  .2 Control signal: 0-10V DC or 4-20 mA DC.
  .3 Positioning time: to suit application. 90 sec maximum.
  .4 Fail to normal position as indicated.
  .5 Scale or dial indication of actual control valve position.
  .6 Size actuator to meet requirements and performance of control valve specifications.
  .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.
  .8 Minimum shut-off pressure: refer to control valve schedule.
  .9 Two position or modulating as indicated in sequence of operation.

2.16 PANELS

.1 Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as required by Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

2.17 WIRING

.1 In accordance with Section 26 27 10 - Modular Wiring System, 26 27 26 - Wiring Devices.

.2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.

.3 Wiring must be continuous without joints.

.4 Sizes:
  .1 Field wiring to digital device: #18AWG stranded twisted pair.
  .2 Analog input and output: shielded #18 stranded twisted pair.

2.18 DUCT AIRFLOW STATION

.1 Provide where indicated and/or scheduled airflow traverse elements capable of continuously monitoring the fan or duct air volumes they serve.

.2 The airflow measurement station shall consist of multiple airflow elements, factory mounted and pre-piped in a casing designed for flanged connection to the ductwork.

.3 Accuracy: within 2% of actual flow.

.4 Material:
.1 Elements: 6063-T5 anodized aluminum (standard)
.2 Casings: 16 ga G90 galvanized steel (standard)

.5 Rated operating conditions: Up to 350 Deg.F and 0-100% humidity.

.6 Instrument Connections: ¼" compression, suitable for use with thermoplastic or copper tubing; thermoplastic tubing requires the use of tubing inserts, which shall be supplied with the fittings.

.7 Each element shall be designed and built to comply with, and provide results in accordance with, accepted practice for duct system traversing as defined in the ASHRAE Handbook of Fundamentals, AMCA publication #203, as well as the Industrial Ventilation Handbook. The number of sensing ports on each element, and the quantity of elements utilized at each installation, shall comply with ASHRAE Standard #111 for equal area duct traversing.

.8 Each airflow measuring element shall contain multiple total and static pressure sensing ports placed along the leading edge of the cylinder. The static pressure chamber shall incorporate dual offset static taps on opposing sides of the averaging chamber, so as to be insensitive to flow angle variations of as much as ± 20 degrees in the approaching airstream.

.9 The airflow traverse elements shall be capable of producing steady, non-pulsating signals of true total and static pressure, with an accuracy of 2% of actual flow for operating velocities as low as 100 feet per minute (fpm). Signal amplifying sensors requiring flow correction (K factors) for field calibration are not acceptable.

.10 The airflow traverse elements shall not induce a measurable pressure drop, greater than 0.18 inch at 4,000 fpm. The units shall have a self-generated sound rating of less than NC40 and the sound level within the duct shall not be amplified, nor shall additional sound be generated.

.11 The probes shall be manifolded together in a 16 gauge galvanized steel duct section with 90 degree undrilled flanges, fabricated to the duct size, and shall contain multiple airflow traverse elements interconnected as herein before described.

.12 Where primary flow elements are located outside of the manufacturer's published installation guidelines the manufacturer shall be consulted, and approve of any special configurations, such as air equalizers and/or additional and strategically placed measuring points, as may be required.

.13 Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be sized to facilitate matching connecting ductwork.

.14 Airflow station dimensions shall match associated ductwork.

.15 Design is based on Paragon Controls Inc. Model FE-1500.

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, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, 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 in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.

.6 Electrical:

- .1 Complete installation in accordance with Section 26 05 01 - Common Work Results - Electrical.
- .2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.
- .3 Refer to electrical control schematics included as part of control design schematics in Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative 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 or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application 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 non-corroding shields.
- .2 Install in NEMA 4 enclosures.

.4 Duct installations:
- .1 Do not mount in dead air space.
- .2 Locate within sensor vibration and velocity limits.
- .3 Securely mount extended surface sensor used to sense average temperature.
- .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
- .5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.
- .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
- .2 Wire multiple sensors in series for low temperature protection applications.
- .3 Wire multiple sensors separately for temperature measurement.
- .4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.
- .1 Reuse existing wells.
- .2 Thermowell to restrict flow by less than 30%.
- .3 Use thermal conducting paste inside wells.

3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

3.4 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

3.5 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. Sequence of Operation for each system, which the EMCS must accomplish in full.

1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.
1. MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

1.3 SEQUENCING

.1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.

Part 2 - Products

2.1 NOT USED

.1 Not Used.

Part 3 - Execution

3.1 SEQUENCE OF OPERATION

.1 The Energy Management Routines stated as a requirement of the EMCS under Section 25 30 01 EMCS: Building Controls, Item 2.4.8 shall be incorporated under each and every Sequence of Operation to which they apply. Controls Contractor shall write energy management routines into Sequence of Operation submitted for review. This includes, but is not limited to, the following:
.1 Optimal Start/Stop: To be incorporated for each and every system being scheduled through the EMCS. Optimal start/stop to include recovery time from night setback.
.2 Night Setback Control: To be incorporated for each and every comfort heating and cooling systems that are operational through unoccupied periods.
.3 Night Purge: Air handling unit to incorporate differential enthalpy controlled night purge sequence to precool building when conditions permit.

.2 <u>Radiant Ceiling Panel</u>:
.1 Schedule of Operation:
.1 EMCS shall schedule occupied/unoccupied zone control with AHU-1 schedule. Initial schedule shall be as follows:
Occupied Monday – Friday: 7:00 AM – 5:00 PM
.2 Temperature Control:
.1 Unit shall be controlled by EMCS. Wall sensor to be stainless steel plate sensor in washrooms and adjustable sensor in other areas.

.2 Adjustable sensors shall have a midpoint setpoint with a space adjustable slider to increase and decrease setpoint by an operator adjustable amount, initially set to 1.5 Deg.C. The midpoint shall reset between an adjustable summer setpoint, initially set to 24 Deg.C and an adjustable winter setpoint, initially set to 22 Deg.C. Reset shall be based on the following:

Outdoor Temperature	Setpoint
26 Deg.C and above	Summer Setpoint (24 Deg.C)
16 Deg.C and below	Winter Setpoint (21 Deg.C)

.3 On a call for heat, EMCS shall open the two position, two-way valve. Valve shall close once space is satisfied.

.3 Operator Work Station: The operator will be able to view and/or modify the following:

.1 Space temperature
.2 Space temperature setpoint
.3 Night setback summer setpoint
.4 Night setback winter setpoint

.3 Zone Control Sequence A (Meeting Space):

.1 EMCS shall schedule occupied/unoccupied zone control. Initial schedule shall be as follows:

Occupied Monday – Friday: 7:00 AM – 5:00 PM

.2 Occupant override on thermostat shall permit occupied operation during scheduled unoccupied periods for an adjustable time period between 1 and 3 hours, initially set to 2 hours.

.3 Temperature Setpoint:

.1 Temperature shall be controlled from a wall mounted thermostat with an EMCS median room temperature setpoint and an occupant adjustable slider EMCS controlled median setpoint shall reset based on OAT. Reset parameters shall all be adjustable and shall be initially set to the following:

Outdoor Temperature	Setpoint
26 Deg.C. and above	24 Deg.C.
16 Deg.C. and below	21 Deg.C.

.2 EMCS shall control limit on occupancy adjustment, initially set to +/- 3 Deg.C (adjustable parameter).

.3 EMCS shall incorporate night setback during unoccupied periods. During such periods, the EMCS shall disable the adjustable slider and control the space to the night setback temperature, as follows:

Winter Night Set Back = 18 Deg.C. (adjustable parameter)
Summer Night Set Back = 26 Deg.C. (adjustable parameter)

.4 Spaces with multiple thermostats in operation shall control to average setpoint between all thermostats in space.

.4 Airflow Control:

.1 Supply valves shall maintain supply airflow at minimum according to occupied or unoccupied mode at all times except where temperature control requires airflow to increase. All supply valves controlled from the same thermostat shall modulate equally between minimum and maximum airflow.

.2 All return air valves in the space shall modulate from minimum to maximum, as required to maintain air flow offset between total supply air and total return air. During unoccupied mode, all exhaust air valves shall be closed.

.3 For each separately controlled space, EMCS shall show each valve and associated points, summation of airflow for all supply valves in space, summation of airflow for all return valves in space, and airflow offset setpoint.

.5 Temperature Control - Heating:

.1 The terminal unit airflow, reheat valve, and radiant panel modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be the first stage of heat. During the first stage of heat the reheat coil two-way modulating valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room temperature setpoint. Radiant panel modulating two-way valves shall modulate to maintain space temperature.

.3 Where radiant panels are not present or if the radiant panel is unable to maintain setpoint, the discharge air temperature setpoint shall gradually increase to maximum while maintaining minimum airflow. Maximum discharge air setpoint shall be initially set to 7 Deg.C. above room setpoint.

.4 If the radiant panel and reheat coil at maximum discharge temperature and minimum airflow are unable to maintain setpoint, the EMCS shall modulate supply air valves to increase airflow.

.5 Radiant panels shall be locked out during summer operation, when ambient temperature is above summer flag.

.6 Temperature Control - Cooling:

.1 The terminal unit airflow and reheat valve modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be off (valve closed) on a call for cooling.

.3 At minimum air flow, the reheat valve shall modulate to maintain discharge air temperature at 2 Deg.C below room setpoint. Discharge air temperature shall reset down to suit space cooling demand.

.4 Once the reheat valve is closed, a call for more cooling shall enable airflow to increase from minimum to maximum to suit space demand.

.7 Override Mode:

.1 If the occupancy override button is activated during unoccupied periods then the EMCS shall revert to occupied control for that space for the duration of the override period. Override period to be adjustable between 30 minutes and 180 minutes, initially set to 120 minutes.

.8 Graphics: The operator will be able to view and/or modify the following:

1. Each air valve Air Flow
2. Each air valve Air Flow set point (occupied/unoccupied minimum and maximum)
3. Each air valve Damper Position
4. Room Temperature
5. Room Temperature Occupant offset
6. EMCS Room Temperature Median Setpoint
7. Occupancy adjustment limits
8. Each Reheat Valve Position
9. Each Radiant Panel valve Position
10. Total supply air flow
11. Total Return airflow
12. Total airflow offset

13. Maximum discharge air temperature above room setpoint
14. Occupancy override period

.9 Alarm Conditions: The following alarms will not shut the system off:

1. Discharge air temperature alarm (Air valve discharge air temperature is 5 deg.C above AHU-1 discharge air temperature when reheat valve is closed), 5 minute delay.

.4 Zone Control Sequence B (Enclosed Office/Common Space):

.1 EMCS shall schedule occupied/unoccupied zone control. Initial schedule shall be as follows:

Occupied Monday – Friday: 7:00 AM – 5:00 PM

.2 Occupant override on thermostat shall permit occupied operation during scheduled unoccupied periods for an adjustable time period between 1 and 3 hours, initially set to 2 hours.

.3 Temperature Setpoint:

.1 Temperature shall be controlled from a wall mounted thermostat with an EMCS median room temperature setpoint and an occupant adjustable slider EMCS controlled median setpoint shall reset based on OAT. Reset parameters shall all be adjustable and shall be initially set to the following:

Outdoor Temperature	Setpoint
26 Deg.C and above	24 Deg.C
16 Deg.C and below	21 Deg.C

.2 EMCS shall control limit on occupancy adjustment, initially set to +/- 3 Deg.C. (adjustable parameter).

.3 EMCS shall incorporate night setback during unoccupied periods. During such periods, the EMCS shall disable the adjustable slider and control the space to the night setback temperature, as follows:

Winter Night Set Back = 18 Deg.C. (adjustable parameter)
Summer Night Set Back = 26 Deg.C. (adjustable parameter)

.4 Spaces with multiple thermostats in operation shall control to average setpoint between all thermostats in space.

.4 Airflow Control:

.1 Supply valves shall maintain supply airflow at minimum according to occupied or unoccupied mode at all times except where temperature control requires airflow to increase. All supply valves controlled from the same thermostat shall modulate equally between minimum and maximum airflow.

.2 All return air valves in the space shall modulate from minimum to maximum, as required to maintain air flow offset between total supply air and total return air. During unoccupied mode, all return air valves shall be closed.

.3 For each separately controlled space, EMCS shall show each valve and associated points, summation of airflow for all supply valves in space, summation of airflow for all return valves in space, and airflow offset setpoint.

.5 Temperature Control - Heating:

.1 The terminal unit airflow, reheat valve, and radiant panel modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be the first stage of heat. During the first stage of heat the reheat coil two-way modulating valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room temperature setpoint. Radiant panel two-position two-way valves shall open on a call for heat and close once space is satisfied.

.3 Where radiant panels are not present or if the radiant panel is unable to maintain setpoint, the discharge air temperature setpoint shall gradually increase to maximum while maintaining minimum airflow. Maximum discharge air setpoint shall be initially set to 7 Deg.C. above room setpoint.

.4 If the radiant panel and reheat coil at maximum discharge temperature and minimum airflow are unable to maintain setpoint, the EMCS shall modulate supply air valves to increase airflow.

.6 Temperature Control - Cooling:

.1 The terminal unit airflow and reheat valve modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be off (valve closed) on a call for cooling.

.3 At minimum air flow, the reheat valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room setpoint. Discharge air temperature shall reset down to suit space cooling demand.

.4 Once the reheat valve is closed, a call for more cooling shall enable airflow to increase from minimum to maximum to suit space demand.

.7 Override Mode:

.1 If the occupancy override button is activated during unoccupied periods then the EMCS shall revert to occupied control for that space for the duration of the override period. Override period to be adjustable between 30 minutes and 180 minutes, initially set to 120 minutes.

.8 Graphics: The operator will be able to view and/or modify the following:

1. Each air valve Air Flow
2. Each air valve Air Flow set point (occupied/unoccupied minimum and maximum)
3. Each air valve Damper Position
4. Room Temperature
5. Room Temperature Occupant offset
6. EMCS Room Temperature Median Setpoint
7. Occupancy adjustment limits
8. Each Reheat Valve Position
9. Each Radiant Panel valve Position
10. Total supply air flow
11. Total Return airflow
12. Total airflow offset
13. Maximum discharge air temperature above room setpoint
14. Occupancy override period

.9 Alarm Conditions: The following alarms will not shut the system off:
1. Airflow offset alarm (cannot maintain desired airflow offset), 5 minute delay
2. Discharge air temperature alarm (Air valve discharge air temperature is 5 deg.C above AHU-1 discharge air temperature when reheat valve is closed), 5 minute delay

.5 Zone Control Sequence C (Open Office Space with Common Return):

.1 EMCS shall schedule occupied/unoccupied zone control. Initial schedule shall be as follows:

Occupied Monday – Friday: 7:00 AM – 5:00 PM

.2 Occupant override on thermostat shall permit occupied operation during scheduled unoccupied periods for an adjustable time period between 1 and 3 hours, initially set to 2 hours.

.3 Zone Temperature Setpoint:

.1 Temperature in each zone shall be controlled from a wall mounted thermostat with an EMCS median room temperature setpoint and an occupant adjustable slider EMCS controlled median setpoint shall reset based on OAT. Reset parameters shall all be adjustable and shall be initially set to the following:

Outdoor Temperature	Setpoint
26 Deg.C. and above	24 Deg.C.
16 Deg.C. and below	21 Deg.C.

.2 EMCS shall control limit on occupancy adjustment, initially set to +/- 3 Deg.C. (adjustable parameter).

.3 EMCS shall incorporate night setback during unoccupied periods. During such periods, the EMCS shall disable the adjustable slider and control the space to the night setback temperature, as follows:

Winter Night Set Back = 18 Deg.C. (adjustable parameter)
Summer Night Set Back = 26 Deg.C. (adjustable parameter)

.4 Spaces with multiple thermostats in operation shall control to average setpoint between all thermostats in space.

.4 Airflow Control:

.1 Supply valve for each zone shall maintain supply airflow at minimum according to occupied or unoccupied mode at all times except where temperature control requires airflow to increase. All supply valves controlled from the same thermostat shall modulate equally between minimum and maximum airflow.

.2 The return air control valve shall modulate from minimum to maximum as required to track the summation of associated supply valves less a pressurization offset. Offset to be adjustable, initially set to 10% of total supply. During unoccupied mode, return damper shall be closed.

.3 For each separately controlled zone, EMCS shall show components operating in zone. A separate graphic shall show return damper and associated supply valves including summation of airflows. .

.5 Temperature Control - Heating:

.1 The terminal unit airflow, reheat valve, and radiant panel modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be the first stage of heat. During the first stage of heat the reheat coil two-way modulating valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room temperature setpoint. Radiant panel two-position two-way valves shall open on a call for heat and close once space is satisfied.

.3 Where radiant panels are not present or if the radiant panel is unable to maintain setpoint, the discharge air temperature setpoint shall gradually increase to maximum while maintaining minimum airflow. Maximum discharge air setpoint shall be initially set to 7 Deg.C. above room setpoint.

.4 If the radiant panel and reheat coil at maximum discharge temperature and minimum airflow are unable to maintain setpoint, the EMCS shall modulate supply air valves to increase airflow.

.6 Temperature Control - Cooling:

.1 The terminal unit airflow and reheat valve modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be off (valve closed) on a call for cooling.

.3 At minimum air flow, the reheat valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room setpoint. Discharge air temperature shall reset down to suit space cooling demand.

.4 Once the reheat valve is closed, a call for more cooling shall enable airflow to increase from minimum to maximum to suit space demand.

.7 Override Mode:

.1 If the occupancy override button is activated during unoccupied periods then the EMCS shall revert to occupied control for that space for the duration of the override period. Override period to be adjustable between 30 minutes and 180 minutes, initially set to 120 minutes.

8. Graphics: The operator will be able to view and/or modify the following:

1. Each air valve Air Flow
2. Each air valve Air Flow set point (occupied/unoccupied minimum and maximum)
3. Each air valve Damper Position
4. Each zone Temperature
5. Each zone Temperature Occupant offset
6. EMCS Zone Temperature Median Setpoint
7. Occupancy adjustment limits
8. Each Reheat Valve Position
9. Each Radiant Panel valve Position
10. Total supply air flow (summation of all supply valves associated with common return)
11. Common Return airflow (airflow through airflow station at damper)
12. Total airflow offset (difference between supply and return)
12. Total airflow offset setpoint (difference between supply and return)
13. Maximum discharge air temperature above room setpoint
14. Occupancy override period

.9 Alarm Conditions: The following alarms will not shut the system off:

1. Airflow offset alarm (cannot maintain desired airflow offset), 5 minute delay

2. Discharge air temperature alarm (Air valve discharge air temperature is 5 deg.C above AHU-1 discharge air temperature when reheat valve is closed), 5 minute delay

.6 Dedicated Air Conditioning Units (AC-1/CU-1):

.1 Each dedicated air conditioning unit shall operate from a local programmable thermostat matched to the air conditioning unit.

.2 Install and wire controls associated with AC unit.

.3 The EMCS shall monitor space temperature from stainless steel sensor (separate from ACU temperature sensor) and alarm on high limit.

.4 The Facility Management System shall monitor and address all points required to meet sequence of operation, including but not limited to the following:

- Space temperature
- Space temperature high limit (initially set to 26 Deg.C.)

.7 Terminal Control Sequence Room 123 – Lab Space:

.1 EMCS shall schedule occupied/unoccupied zone control. Initial schedule shall be as follows:

Occupied Monday - Friday: 7:00 AM - 5:00 PM

.2 Occupant override on thermostat shall permit occupied operation during scheduled unoccupied periods for an adjustable time period between 1 and 3 hours, initially set to 2 hours.

.3 Temperature Setpoint:

.1 Temperature shall be controlled from a wall mounted thermostat with an EMCS median room temperature setpoint and an occupant adjustable slider EMCS controlled median setpoint shall reset based on OAT. Reset parameters shall all be adjustable and shall be initially set to the following:

Outdoor Temperature	Setpoint
26 Deg.C. and above	24 Deg.C.
16 Deg.C. and below	21 Deg.C.

.2 EMCS shall control limit on occupancy adjustment, initially set to +/- 3 Deg.C. (adjustable parameter).

.3 EMCS shall incorporate night setback during unoccupied periods. During such periods, the EMCS shall disable the adjustable slider and control the space to the night setback temperature, as follows:

Winter Night Set Back = 18 Deg.C. (adjustable parameter)
Summer Night Set Back = 26 Deg.C. (adjustable parameter)

.4 Airflow Control (Room Constant Volume Exhaust):

.1 Laboratory airflow control system shall use volumetric offset control to maintain room pressurization. The control unit shall maintain a constant design offset between the sum of the room's total exhaust and make-up/supply air flows. This offset shall be field adjustable and represents the volume of air which will enter (or exit) the room from the corridor or adjacent spaces. Supply air valves, exhaust air valves, fume hoods, canopy exhausts, and associated dedicated exhaust fans operating within space shall maintain the total room exhaust airflow at constant flow and offset the total supply air flow to maintain negative flow offset (less supply than exhaust).

.2 The laboratory airflow offset between supply and exhaust shall be maintained at all times.

.3 Air valves noted as variable volume shall modulate from minimum to maximum to maintain room airflow offset.

.4 Air valves noted as constant volume shall modulate to maintain a constant air volume in accordance with the occupied and unoccupied constant volume setpoint.

.5 Modulate the motorized damper associated with EF-32 serving Room 123 to maintain constant flow at all times.

.6 The EMCS shall monitor the operation of exhaust systems not provided with air flow stations (fume hoods and bio-safety cabinets). When these systems are enabled, the EMCS shall utilize the site verified constant volume air flow for each system in its room exhaust air flow calculation.

.5 Constant Pressure Exhaust Valve Control:

.1 Associated exhaust fans are controlled from switches mounted in space. The EMCS shall monitor fan status.

.2 Constant Pressure exhaust valves shall be enabled when their associated Exhaust Fans are enabled. CP valves without associated exhaust fans, shall be enabled during occupied periods.

.3 When enabled, the EMCS shall modulate the exhaust valve damper to maintain the constant pressure setpoint as measured through the static pressure sensor.

.4 When Exhaust Fan EF-32 is off, the exhaust valve shall remain closed when the Bench Exhaust fan is enabled. The EMCS shall alarm initiation of a bench exhaust system when EF-32 is off.

.6 Temperature Control - Heating:

.1 The terminal unit reheat valves modulate to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.2 Where present, radiant panels shall be the first stage of heat. During the first stage of heat the reheat coil two-way modulating valve shall modulate to maintain discharge air temperature at 2 Deg.C. below room temperature setpoint. Radiant panel two-position two-way valves shall open on a call for heat and close once space is satisfied.

.3 Where radiant panels are not present or if the radiant panel is unable to maintain the desired space temperature, the discharge air temperature setpoint shall gradually increase to maximum while maintaining minimum airflow. Note that minimum airflow in the lab space can be either the room airflow minimum or the room offset from the summation of exhaust devices and valves operating at any given moment. Maximum discharge air setpoint shall be initially set to 7 Deg.C. above room setpoint.

.4 If the radiant panel in combination with the reheat coil at maximum discharge temperature and minimum airflow are unable to maintain the space setpoint, the EMCS shall permit the room airflow to increase.

.7 Temperature Control - Cooling:

.1 The terminal unit airflow and reheat valve modulate in sequence to maintain room temperature setpoint. Temperature setpoint is determined from the EMCS controlled median temperature and the occupant adjustable space offset.

.8 Fume Hood Control (H-5 No Switch):
- .1 The fume hood exhaust fan shall operate continuously.
- .2 At start up, the EMCS shall open the motorized isolation damper before starting the exhaust fan.
- .3 The EMCS shall monitor and control the following fume hood points:
  1. Fume hood exhaust fan start/stop/status, alarm
  2. Exhaust fan proof (output to VSP panel)
  3. Fan failure alarm (output to VSP panel)
  4. Power On Indication (output to VSP panel)

.9 Override Mode:
- .1 If the temperature sensor override button is activated during unoccupied periods then the EMCS shall revert to occupied control for that space for the duration of the override period. Override period to be adjustable between 30 minutes and 180 minutes, initially set to 120 minutes.

.10 Graphics: The operator will be able to view and/or modify the following:
1. Each air valve Air Flow
2. Each air valve Air Flow set point (occupied/unoccupied minimum and maximum)
3. Each air valve Damper Position
4. Room Temperature
5. Room Temperature Occupant offset
6. EMCS Room Temperature Median Setpoint
7. Each Reheat Valve Position
8. Each Radiant Panel valve Position
9. Total supply air flow
10. Total Exhaust airflow
11. Total airflow offset
12. Schedule
13. All fume hood panel points, start/stop/status and alarm
14. All exhaust fans associated with constant pressure exhaust, fan status
15. EF-32 Start, stop, status. Alarm.
16. Exhaust flow through Motorized Damper MD-EF32.1. (airflow station)
17. Exhaust flow setpoint through Motorized Damper MD-EF32.1.
18. Motorized Damper MD-EF32.1 position.

.11 Alarm Conditions: The following alarms will not shut the system off:
1. Airflow offset alarm (cannot maintain desired airflow offset)
2. Discharge air temperature alarm (Air valve discharge air temperature is 5 deg.C above AHU-1 discharge air temperature when reheat valve is closed)

.8 <u>Room 120 Ventilation Control (Sequence G):</u>

.1 Schedule of Operation:
- .1 This system operates on an occupied/unoccupied schedule as programmed into the EMCS system. System shall run following a schedule initially set for 7:00am – 5:00pm Monday-Friday.

.2 Ventilation Control:
- .1 During unoccupied periods, exhaust fan shall continue to operate and supply valve SV1.35 shall remain open.
- .2 During occupied periods, exhaust fan and supply valve SV1.35 shall operate and maintain a negative pressure (offset air flow) in the space.

.3 Carbon Monoxide Control:
- .1 EMCS shall monitor carbon monoxide sensors in space at all times.
- .2 Alarm on Carbon Monoxide high level detection

.4 Operator Work Station: The operator will be able to view and/or modify the following:
1. Exhaust Fan EF-32 start/stop/status/alarm
2. Supply valve Damper Position
3. Carbon Monoxide Level
4. Carbon Monoxide lower limit setpoint
5. Carbon Monoxide upper limit setpoint
6. Carbon Monoxide 15 minute alarm limit setpoint
7. Carbon Monoxide 60 minute alarm limit setpoint
8. Motorized Damper MD-EF32.2 position
9. Exhaust flow through Motorized Damper MD-EF32.2 (airflow station)
10. Exhaust flow setpoint through Motorized Damper MD-EF32.2.

.5 Alarm Conditions: The following alarms will not shut the system off:
1. Carbon monoxide 15 minute high limit alarm: exceeds 198 ppm for 15 minutes (fixed parameters
2. Carbon monoxide 60 minute high limit alarm: exceeds 25 ppm for 60 minutes (adjustable time)

.9 <u>Room 127 Ventilation Control:</u>

.1 Schedule of Operation:
- .1 This system operates on an occupied/unoccupied schedule as programmed into the EMCS system. System shall run following a schedule initially set for 7:00am – 5:00pm Monday-Friday.

.2 Ventilation Control:
- .1 During unoccupied periods, motorized damper MD1.1 shall be closed and EV1.27 shall be closed.
- .2 During occupied periods, motorized damper MD1.1 shall be open and EV1.27 shall control airflow to minimum ventilation rate.

.3 Carbon Monoxide Control:
- .1 EMCS shall monitor carbon monoxide sensors in space at all times.
- .2 If carbon monoxide is detected (or exceeds low limit), EV1.27 and MD1.1 shall close.
- .3 Alarm on Carbon Monoxide detection

.4 Operator Work Station: The operator will be able to view and/or modify the following:
1. Exhaust valve Air Flow
2. Exhaust valve Air Flow set point (occupied/unoccupied minimum and maximum)
3. Exhaust valve Damper Position
4. Carbon Monoxide Level
5. Carbon Monoxide lower limit setpoint
6. Carbon Monoxide upper limit setpoint
7. Carbon Monoxide 15 minute alarm limit setpoint
8. Carbon Monoxide 60 minute alarm limit setpoint
9. Motorized Damper MD1.1 position

.5 Alarm Conditions: The following alarms will shut the system off:
1. Carbon monoxide 15 minute high limit alarm: exceeds 198 ppm for 15 minutes (fixed parameters).
2. Carbon monoxide exceeds detection low limit (to be confirmed on site).

.10 Main Air Handling System AHU-1:

.1 Schedule of Operation:

.1 System shall operate on an occupied/unoccupied EMCS schedule. AHU1, EF-29 and EF30 shall operate 24 hours a day 7 days a week (i.e. operate in both occupied and unoccupied modes).

.2 The EMCS shall permit scheduled downtime for maintenance, and as required for unscheduled repairs.

.2 Fan Control:

.1 AHU-1 outside air damper shall open when manual freeze stat is off and fan system point is on at the EMCS workstation. Fans SF1 and SF1A shall start and the variable speed drive shall ramp up from 20 to 100% in 2% increments every 30 seconds until the remote static pressure control value is reached. SF1 and SF1A fan speeds shall modulate to maintain the lowest static pressure reading from the 6 pressure sensors (SP-1 to SP-6) in various supply ducts throughout the building at a set point of 150 Pascal. Each fan has a High limit static pressure controller which will override the remote static pressure controller and reduce fan speed if the discharge static pressure for the corresponding fan is greater than the high limit static pressure set point (SF1_SPHL = 855pascals and SF1A_SPHL = 855pascals).

.2 EF29 motorized damper is enabled when SF1 or SF1A fan status is on. Once EF29 damper end switch is proven EF29 fan motor is enabled.

.3 Once SF1 or SF1A fan status is on, EF30 fan motor is enabled and the variable speed drive shall ramp up from 20 to 100% in 2% increments every 30 seconds until the remote static pressure control value is reached. EF30 fan speeds shall modulate to maintain the minimum negative static pressure reading from the 6 pressure sensors (SP-7 to SP-12) in various exhaust ducts throughout the building at a set point of -20 Pascal.

.3 Temperature Control:

.1 The EMCS shall modulate the heat recovery valve HRC4-CV, cooling coil valves CC1-CVA and CC1-CVB, preheat valves HC1-CVA and HC1-CVB, and economizer dampers in sequence to maintain AHU-1 supply air temperature setpoint.

.2 The supply air temperature set point shall reset based on outside air temperature as shown below;

Outside Air Temperature	Supply Air Temperature Setpoint
-20 Deg.C.	18 Deg.C
20 Deg.C.	11 Deg.C.

Reset setpoint values shall be operator adjustable.

.4 Heating Control:

.1 The EMCS shall modulate the heat recovery valve HRC4-CV and preheat valves HC1-CVA and HC1-CVB in sequence to maintain AHU-1 supply air temperature setpoint. When heating, cooling coil valves shall be closed.

.2 Heat Recovery Coil (HRC4): Heat recovery Pump P-22 shall enable for heating when SF1 or SF1A status is on and Main Heat Recovery Pumps are in heating mode. The 3-way mixing valve shall modulate to maintain discharge temperature or to provide maximum output when desired discharge temperature cannot be reached by heat recovery alone. When

P-22 is off, the 3-way mixing valve shall be open to system (no flow through coil).

.3 EMCS shall monitor heat recovery leaving water temperature and mixed water temperature. The EMCS shall override the 3-way mixing valve if the mixed water temperature drops below a low limit setpoint, initially set to 1°C, to prevent ice from forming on exhaust heat recovery coils. Mixing valve will modulate to maintain a mixed water temperature above freezing.

.4 Heating coil HC1: Heating Pumps P5 and P5A shall enable when the outside air temperature is below P5_OAT_START set point (10°C) and stop when outside air temperature rises 2 deg.C above P5_OAT_START set point (12 deg.C). Pumps operate in a parallel configuration.

.5 Control valves HC1_CVA and HC1_CVB shall modulate in sequence to maintain discharge air temperature at setpoint;

.6 EMCS shall override both control valves in a staged fashion to maintain a minimum heating coil discharge air temperature of 2 deg.C at all times.

.7 Economizer dampers shall be maintained at minimum ventilation when heating.

.5 Cooling Control:

.1 The EMCS shall modulate the heat recovery valve HRC4-CV, economizer dampers, and cooling valves CC1-CVA and CC1-CVB in sequence to maintain AHU-1 supply air temperature setpoint. When cooling, heating control valves shall be closed.

.2 Heat Recovery coil (HRC4): Heat recovery Pump P-22 shall enable for cooling when SF1 or SF1A status is on and Main Heat Recovery Pumps are in cooling mode. The 3-way mixing valve shall modulate to maintain discharge temperature or to provide maximum output when desired discharge temperature cannot be reached by heat recovery alone. When P-22 is off, the 3-way mixing valve shall be open to system (no flow through coil).

.3 Cooling coil CC1: Once AHU1 airflow is above 1000 l/s, the cooling control valves CC1_CVA and CC1_CVB shall modulate in sequence to maintain discharge air temperature. Cooling control valves shall close when AHU1 airflow is less than 1000 l/s or when HC-1 is heating

.6 Humidity Control (enabled at OAT < 10 deg.C.):

.1 The EMCS shall communicate with humidifier HUM-1 and HUM-1A on board controllers to maintain desired exhaust air humidity setpoint. When AHU-1 airflow is less than 1000 L/s or OAT is above humidification limit, initially set to 12 deg.C., the humidifiers shall be off. When AHU1 airflow is greater than 1000 l/s humidifiers shall modulate to maintain the exhaust air humidity set point (Exhaust Fan 30). Exhaust air humidity set point is reset based on OAT as shown below;

Outside Air Temperature	Supply Air Temperature Setpoint
-20 Deg.C.	20 %
10 Deg.C.	35%

.2 Supply air discharge humidity high limit controller, one for each humidifier, shall override the exhaust air humidity setpoint control and maintain discharge air humidity in AHU1 at 75% RH.

.3 EMCS shall monitor alarms from humidifier controllers.
- Humidification valves disabled at 0%

.7 Economizer Control:

.1 Replace on/off damper control for EF-30 and SF-1/1A with modulating control.

.2 Modulate existing outside air damper, EF-30 discharge damper and new mixed air damper to suit discharge air control temperature when ambient conditions permit.

.3 When mechanical heating, modulate dampers to minimum ventilation position (assumed to be 30% outside air or as determined on site with balancing contractor).

.4 When mechanical cooling and ambient temperature is within 1 deg.c of return air temperature or above, modulate dampers to minimum ventilation position (assumed to be 30% outside air or as determined on site with balancing contractor).

.8 Protection: Three manually reset low temperature freeze stats located downstream of the heating coil will shut down the supply fans, close the outside air dampers and modulate heating coil valves to maintain the heating coil discharge air temperature.

.9 Operator Work Station: The operator will be able to view and/or modify the following:

.1 Supply Fan SF-1 AND SF-1A: Start, Stop, Status, Speed, Alarm, VSD fault, VSD speed feedback.
.2 Flow measuring station airflow FMS-4
.3 Flow measuring station airflow FMS-4A
.4 Supply Fan SF-1 airflow
.5 Supply Fan SF-1 discharge static pressure
.6 Supply Fan SF-1 discharge static pressure high limit setpoint
.7 Flow measuring station airflow FMS-5
.8 Flow measuring station airflow FMS-5A
.9 Supply Fan SF-1A airflow
.10 Supply Fan SF-1A discharge static pressure
.11 Supply Fan SF-1A discharge static pressure high limit setpoint
.12 AHU-1 Outside air damper position
.13 Exhaust Fan EF-29: Start, Stop, Status.
.14 Exhaust Fan EF-29 discharge damper position
.15 Exhaust Fan EF-29 discharge damper endswitch condition.
.16 Exhaust Fan EF-29 airflow (Flow measuring station FMS-1)
.17 Exhaust Fan EF-30: Start, Stop, Status, Speed, alarm, VSD fault, VSD speed feedback.
.18 Exhaust Fan EF-30 discharge damper position
.19 Flow measuring station airflow FMS-2
.20 Flow measuring station airflow FMS-2A
.21 Exhaust Fan EF-30 airflow
.22 Heat reclaim coil HRC-4 discharge air temperature
.23 Heat reclaim coil circulation Pump P-22: Start, Stop, Status, Alarm
.24 Heat reclaim coil HRC-4 control valve position
.25 Heat reclaim coil HRC-4 leaving water temperature
.26 Heat reclaim coil HRC-4 mixed water temperature
.27 Heat reclaim coil HRC-4 mixed water temperature low limit setpoint
.28 Heat reclaim coil HRC-1 entering air temperature

.29 Heat reclaim coil HRC-1 entering air temperature
.30 Heat reclaim coil HRC-1 leaving water temperature
.31 Heat reclaim coil HRC-2 entering air temperature
.32 Heat reclaim coil HRC-2 leaving air temperature
.33 Heat reclaim coil HRC-2 leaving water temperature
.34 Freezestat alarm setpoint
.35 Freezestat temperature
.36 Supply Fan SF-1 preheat discharge air temperature
.37 AHU-1 supply air discharge air temperature
.38 AHU-1 supply air discharge air temperature setpoint (reset schedule)
.39 Filter Bank 1 differential pressure
.40 Filter Bank 1 differential pressure service setpoint
.41 Filter Bank 2 differential pressure
.42 Filter Bank 2 differential pressure service setpoint
.43 Filter Bank 7 differential pressure
.44 Filter Bank 8 differential pressure service setpoint
.45 Heating Coil 1 control valve A (HC1-CVA - 1/3 valve) position
.46 Heating Coil 1 control valve B (HC1-CVB - 2/3 valve) position
.47 Heating coil HC-1 pumps P-5 and P-5A: Start, Stop, Status, Alarm.
.48 Heating Coil HC-1 entering water temperature
.49 Heating Coil HC-1 leaving water temperature
.50 Cooling Coil 1 control valve A (CC1-CVA - 1/3 valve) position
.51 Cooling Coil 1 control valve B (CC1-CVB - 2/3 valve) position
.52 Cooling Coil 1 leaving water temperature
.53 Humidifier Status (HUM-1 and HUM-1A)
.54 Humidifier Service (HUM-1 and HUM-1A)
.55 Humidifier Alarm (HUM-1 and HUM-1A)
.56 Humidifier Demand Signal (HUM-1 and HUM-1A)
.57 Humidifier Enable (HUM-1 and HUM-1A)
.58 Humidifier exhaust air relative humidity (HUM-1 and HUM-1A)
.59 Humidifier exhaust air relative humidity setpoint (HUM-1 and HUM-1A) (reset schedule)
.60 Humidifier supply air relative humidity (HUM-1 and HUM-1A)
.61 Humidifier supply air relative humidity high limit setpoint (HUM-1 and HUM-1A)
.62 Mixed air damper position.

.10 Alarm Conditions:

.1 The following system alarms will shut the system down:

1. Freeze stat trip (Mechanical)- manual reset, initial setpoint 2 Deg.C., 5 minute delay
2. Exhaust Fan 30 fan failure

.2 The following alarms will not shut the system down:

1. SF1 supply fan failure: 3 minute delay
2. SF1A Supply Fan Failure: 3 minute delay
3. SF1 variable speed drive fault: 3 minute delay
4. SF1A variable speed drive fault: 3 minute delay
5. Heat recovery coil high temperature >25°C: 1 minute delay
6. Filter 1 differential pressure >100pascals: 5 minute delay
7. Filter 2 differential pressure >100pascals: 5 minute delay
8. Heating coil leaving air temperature >25°C or <7°C: 1 minute delay

9. SF1 high static pressure >2500 pascals: 1 minute delay
10. SF1A high static pressure >2500 pascals: 1 minute delay
11. Supply air temperature >25°C or <7°C: 1 minute delay
12. SF1 flow measuring station >2200 l/s: 1 minute delay
13. SF1A flow measuring station >2200 l/s: 1 minute delay
14. Remote static pressure sensor 1 >1300pascals: 1 minute delay
15. Remote static pressure sensor 2 >1300pascals: 1 minute delay
16. Remote static pressure sensor 3 >1200pascals: 1 minute delay
17. Remote static pressure sensor 4 >1200pascals: 1 minute delay
18. Remote static pressure sensor 5 >1200pascals: 1 minute delay
19. Remote static pressure sensor 6 >1200pascals: 1 minute delay
20. Heat recovery mixed water temperature >40°C or <0°C: 1 minute delay
21. Exhaust air humidity >70%RH or <10%RH: 1 minute delay
22. SF1 supply air humidity alarm >75%RH or <15%RH: 1 minute delay
23. SF1A supply air humidity alarm >75%RH or <15%RH: 1 minute delay
24. P5 heating pump failure: 3 minute delay
25. P5A heating pump failure: 3 minute delay
26. P22 heat reclaim coil pump failure: 3 minute delay
27. SF1 maintenance runtime exceeded >720hrs
28. SF1A maintenance runtime exceeded >720hrs
29. P5 maintenance runtime exceeded >720hrs
30. P5A maintenance runtime exceeded >720hrs
31. P22 heat reclaim coil pump maintenance runtime exceeded >720hrs
32. EF29 Exhaust Fan Failure
33. EF30 Exhaust Fan Failure
34. EF30 Variable Speed Drive Fault
35. Filter 7 differential pressure >115pascals: 1 minute delay
36. Filter 8 differential pressure >115pascals: 1 minute delay
37. EF29 Flow Measuring Station Alarm
38. EF30 Flow Measuring Station Alarm
39. EF29 maintenance runtime exceeded >720hrs
40. EF30 maintenance runtime exceeded >720hrs
41. HUM-1 Fault / Alarm
42. HUM-1 Service Required Alarm
43. HUM-1A Fault / Alarm
44. HUM-1A Service Required Alarm

.11 Commissioning:

.1 Point to Point verification:

.1 EMCS Contractor shall prepare a check sheet that includes all points for all functions of the EMCS. Check sheet shall include sensor calibration.

.2 The Contractor shall complete the check sheet for all items and functions, including failure modes, of the CMS. Once complete, each page shall be signed and dated by the person responsible for conducting the point to point verification. Modifications following initial documentation shall be signed and dated individually. Submit to Department Representative for review one month prior to Performance

Verification testing.

.2 Provide all necessary specialist labour, materials and tools to demonstrate to the Departmental Representative that the EMCS has been commissioned and is operating in compliance with the contract, including verifying sequence of operation as specified with all approved modifications during construction.

.3 PV forms shall be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation and that they operate efficiently and function independently and interactively with other systems as intended with project requirements. Sample Performance Verification Forms are attached for review. The Contractor will develop the required final project-specific commissioning forms in electronic format with the Departmental Representative. Final forms will include any and all modifications to sequence of operation as a result of site conditions and/or accepted modifications during construction.

.4 The Contractor shall verify the operation of each and every system and fill out the appropriate PV forms. The Departmental Representative and the Contractor shall retest a sampling of systems and components to verify commissioning testing and associated documentation is complete and accurate. Provide manpower and instrumentation to re-verify based on the following sampling rate:

1. Non-critical Terminal Units (supply valves, exhaust valves, radiant panels, unit heaters, force flows, etc.): 30% of reported results.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section covers items common to Sections of Electrical Contractor. This section supplements requirements of Division 00 – Procurement and Contracting Requirements, Division 01 – General Requirements, Division 02 – Existing Conditions.

.2 Provide complete and fully operational electrical systems with facilities and services to meet requirements described herein, as shown on the drawings, and in complete accord with applicable codes and ordinances.

.3 Only those items that are specifically indicated as not in contract (N.I.C.) will be omitted.

.4 Contract documents of Divisions 26, 27, and 28 are diagrammatic and approximately to scale, unless detailed otherwise. They establish scope, material and installation quality, and are not detailed installation instructions.

.5 Follow manufacturers' recommended installation details and procedures for equipment supplemented by details given herein and on plans subject to approval of the Consultant.

.6 Examine all drawings to ensure that work under this Division can be properly installed without interference.

.7 Where discrepancies, ambiguities, obvious omissions or errors have been made in drawings and specifications, it shall be the responsibility of the contractor to clarify same prior to tender closing. No allowance will be made after contract award for any expense incurred by him for having to adjust his work to properly conform.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 CODES AND STANDARDS

.1 The electrical installation shall comply with all SaskPower requirements and regulations.

.2 In the event of any inspection authority requesting deviation from the design, notify the Consultant and obtain approval before proceeding with any change.

.3 In no instance, shall the standard established by the drawings and specification be reduced by any code or ordinance. All references to codes and standards shall be to the latest edition.

1.4 CARE, OPERATION AND START-UP

.1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.

.2 Connect to equipment furnished in other Divisions and by Owner including start-up and test.

.3 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.

.4 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 all aspects of its care and operation.

1.5 VOLTAGE RATINGS

.1 Operating voltages: to CAN3-C235-83

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard. Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

1.6 PERMITS, FEES AND INSPECTION

.1 Submit to SaskPower necessary number of drawings and specifications for examination and approval prior to commencement of work.

.2 Pay associated fees.

.3 Notify Consultant of changes required by Electrical Inspection Department prior to making changes.

.4 Furnish Certificates of Acceptance from Electrical Inspection Department and authorities having jurisdiction on completion of work to Consultant.

1.7 MATERIALS AND EQUIPMENT

.1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.

.2 All goods and materials shall be new and carry CSA approval seal. Equipment and material shall be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from the Consultant and the Electrical Inspection Department.

.3 All fire alarm equipment shall carry ULC approval seal.

.4 No deviation from specified materials shall be allowed, except where alternative materials have been specifically accepted in writing.

.5 Where materials are not directly specified by catalogue number and manufacturer's name, a high industry specification grade product shall be provided. The Consultant shall be the sole judge of whether this standard is being met.

.6 All references to known standard specifications shall mean and intend the latest edition of such specifications.

.7 Each major component of equipment shall have manufacturer's name, address, catalogue and serial number in a conspicuous place.

.8 Upon request, provide a complete list of all materials and their manufacture. The contractor will be required to use the materials indicated. Changes in manufactures at a future date will not be acceptable.

.9 Factory assemble panels and component assemblies.

1.8 WORKMANSHIP

.1 All work under this Division shall be executed in a workmanlike and substantial manner, neat in its mechanical appearance and arrangement.

.2 A competent representative shall constantly supervise the work of this Division from beginning to completion and final acceptance. So far as possible, the same supervisor and workmen shall be employed throughout the project's duration.

.3 Material and workmanship not meeting the standard intended and required by this specification shall, upon instruction from the Consultant, be properly replaced without further charge or consideration.

1.9 ELECTRICAL DRAWINGS

.1 They indicate the general location and route of conduit and cable to be installed. Conduit shall be installed in coordination with other services. These include both new and existing services. Prior to excavation anywhere on site, arrange to have all existing services marked. Where space is indicated for future equipment or plant use, leave space clear.

.2 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to the satisfaction of the Consultant at no extra cost.

.3 Ceiling and floor outlet symbols are scaled to centre line of symbol; symbol does not indicate the size or shape. Mounting height shall be measured to the lowest point on ceiling mounted equipments, and above finished surface for wall mounted equipment.

.4 Wall outlets are scaled to the perpendicular centre line of the symbol. Mounting heights for all wall mounted outlets shall be measured to the horizontal centre line.

.5 Where outlets are mounted in masonry walls, outlets should be mounted to the nearest coursing line.

1.10 WORK PROVIDED FOR OTHER DIVISIONS

.1 Provide information as to exact size and location of all required concrete bases, housekeeping pads and curbs required for the installation of equipment of Divisions 26, 27, and 28.

.2 Provide information as to the location and exact size of all openings through floors and walls.

.3 Provide information as to the location and exact size of all equipment supports required within walls, and roof support structure.

.4 Provide electrical connections, circuit protection and disconnect devices for all equipment supplied by other Divisions, including the Owners. Provide motor starters, disconnect switches, thermal switches, etc., for motors supplied by mechanical contractor. Special control equipment being supplied by mechanical contractor shall be installed and wired by that contractor.

1.11 WORK PROVIDED BY OTHER DIVISIONS

.1 All concrete bases, housekeeping pads and curbs required for the installation of equipment of Divisions 26, 27, and 28.

.2 Installation and framing of all openings in walls or floors larger than 150 mm diameter, or rectangular, with one dimension greater than 150 mm.

.3 Openings in millwork for electrical outlets and conduits.

.4 Painting of all panelboard and communication panel trims to match colour scheme where exposed in finished areas.

.5 Firestopping shall be the responsibility of the General Contractor.

1.12 WORK NOT PROVIDED BY THIS DIVISION

.1 Control wiring below 50V for Mechanical Contractor equipment beyond terminal section of each motor control centre, unless specifically indicated otherwise.

1.13 COORDINATION WITH OTHER DIVISIONS

.1 Cooperate fully with the Consultant and other trades of electrically operated equipment to ensure proper arrangement of and provision for all electrical equipment.

.2 Where outlets or equipment may affect architectural or site treatment desired, contact Consultant and for instructions or detailed drawings.

.3 Refer to other Divisions including mechanical, millwork, kitchen equipment, owner supplied equipment, etc, for electrical work in connection with these drawings and specifications.

.4 Location of lighting outlets and receptacles in mechanical or equipment rooms and similar areas shall be finalized during construction to give optimum arrangement. The Consultant shall approve final location before installation.

.5 Supply and install all motor connections, including starters and overload protection and disconnecting devices at motors where required. All motor driven equipment shall be provided with a lockable disconnecting device within line of site of the motor to be disconnected.

.6 Supply and install complete wiring requirements for full voltage in-line devices on single phase equipment such as thermostats, multi-speed switches for unit heaters, force flows, cabinet heaters, etc.

.7 Cutting of openings for electrical outlets in millwork and other similar types of custom-made equipment shall be done by the supplier of this equipment.

.8 Check other Divisions to ensure that suitable provisions have been provided for all motors. It is possible that some motors may vary in size, numbers and characteristics, depending on the equipment manufacturer's specific requirements. Any variations in this regard will not constitute cause for further consideration. The mechanical coordination schedule supplied on the drawings shall be updated with nameplate specifications.

.9 Assume full responsibility for layout of this work and for any damage caused the Owner or other Divisions by improper location or carrying out of this work.

.10 Before commencing work, examine the work of other Divisions, and report at once any defects or interference affecting the work under this Division, or the guarantee of same.

.11 Location of lighting outlets and receptacles in mechanical or equipment rooms and similar areas shall be finalized during construction to give optimum arrangement. The Consultant shall approve final location before installation.

.12 Allow for all hoisting and setting of material and equipment.

1.14 OWNER SUPPLIED EQUIPMENT

.1 Connect all electrically operated equipment supplied by the Owner, as designated on the drawings.

.2 Reconnect all existing electrical services from new and existing electrical sources modified by the work of this contract.

1.15 INSPECTION AND TESTING

.1 During construction and up to final acceptance, make accessible any equipment or wiring for inspection purposes.

.2 All electrically operating equipment shall be left as a complete installation in perfect operating condition, and receive final test in the presence of the Consultant.

.3 Ensure that all power circuitry is properly tested and meets the CSA Ground Resistance Requirements. For any 600 volt systems, a 600 volt megger or hi-pot procedures shall be used for all such tests. Provide documentation for each test within maintenance/commissioning manuals.

.4 On the request of the Consultant, a staff supervisor shall be made available to assist in this inspection work.

.5 At the completion of the installation, voltage tests shall be conducted in the presence of the Consultant. Transformer taps shall be adjusted, and any other corrective measures implemented to assure the proper operation of all electrical equipment. Provide documentation for each test within maintenance/commissioning manuals.

.6 Acceptance tests and commissioning shall be conducted for systems and/or equipment where indicated in the specifications and other standards referenced herein.

.7 Acceptance tests shall meet requirements as required by manufacturer, as outlined in ANSI – NETA 2007 and additional requirements described on drawings and specified herein. All tests shall be documented as per ANSI – NETA 2007 standards and shall include testing results, testing date, testing technician and representative present.

.8 Acceptance tests shall be made up of the following:

.1 Shop Drawing Information Sheets
.2 Static Review Check Sheets
.3 Performance Verifications Sheets
.4 Manufacturer Commissioning and Report
.5 Manufacturer Test Reports, Factory and On Site where required
.6 Test Results not forming part of the Static Review Checks Sheets
.7 Owner / Consultant Demonstration Sheets
.8 Training

.9 Certification of all acceptance tests and commissioning shall be submitted to the Consultant for approval. Tests not conducted to the satisfaction of the Consultant shall be repeated, and no further costs will be considered. Written documentation bearing name and signature of Contractor, Consultant and Owner's personnel present during acceptance tests shall be included in certification reports. Provide for a minimum of twelve (12) hours across three (3) separate meetings with Consultant and Owner for review of acceptance test sheets.

1.16 SHOP DRAWINGS

.1 Submit shop drawings, where specifically called for, or as requested. Shop drawings shall show detailed dimensional and technical information, and shall properly describe each piece of equipment. Where applicable, shop drawings shall include complete schematics and wiring diagrams. These shop drawings shall be sufficiently detailed to permit the Owner's technicians to trouble-shoot and repair the equipment. Equipment shall not be ordered and/or fabricated until shop drawings have been reviewed by the Consultant. Shop Drawings shall include, but not be limited to the following Sections on systems and equipment:

.1 26 05 36 - Cable Trays
.2 26 27 26 - Wiring Devices
.3 26 28 21 - Moulded Case Circuit Breakers
.4 26 50 00 – Lighting

.2 Review of shop drawings shall be for general design, arrangement and appearance only. This Division shall check and correct, if necessary, all manufacturers' drawings before submitting, and shall so indicate on each copy, along with a dated approval stamp. All shop drawings must bear an approval stamp and be signed by the Contractor. This review does not relieve this Division from the responsibility for the final installation being correct in all detail, and fully acceptable to the Consultant. Refer to each section for further shop drawing information.

.3 Refer to General Conditions of the Contract.

.4 Provide nine (9) printed copies and one PDF copy for each Section. Each shop drawing shall be complete with a cover page with the following information:

.1 Specification Section and name
.2 Project name, Owner's name and address
.3 Number of pages in submittal
.4 Contractor and Supplier's name and contact information
.5 Approval stamps with room for Consultant's stamp

.5 Shop drawings for complementary systems and/or equipment shall be submitted at the same time. Partial submittals of related equipment will be rejected or held until all other related shop drawing information has been submitted (i.e. submit all shop drawings for power equipment at the same time). Submittals of shop drawings that are incomplete will be rejected.

1.17 CHANGES

.1 Refer to General and Supplemental Conditions.

.2 Submit complete itemized breakdowns of all extras, deletions, and changes to the Consultant. Breakdown shall include quantities, unit costs and extensions. If requested, support claim by certified copies of supplier's invoices.

.3 The right is reserved to move equipment 3000 mm from location shown without further charge or consideration, provided that such re-location is requested prior to finish being applied.

1.18 CONSULTANT PRICES

.1 Electrical progress claims shall be made on Contractor Progress Report #ES110 provided by the Consultant. A copy of this Progress Report is attached for reference. The Electrical contract price shall be broken down into thirteen (13) parts to facilitate assessment of work done and material supplied. This progress claim shall be submitted simultaneously to the General Contractor and the Consultant, the latter case in duplicate. Refer to General Conditions.

.2 The breakdown shall indicate labour and material to the nearest dollar. Overhead, profit and job expense shall be apportioned to all parts. The breakdown shall be as follows:

.1 Main services
.2 Distribution/Panels

.3 Conduit and boxes
.4 Wire and cable
.5 Motor control
.6 Wiring devices
.7 Lighting fixtures and lamps
.8 Communications systems
.9 Security Systems
.10 Fire Alarm System
.11 Specials
.12 Miscellaneous - 8% maximum
.13 Extras and credits. (Extras in excess of $1,000 shall be broken down into the above points on a separate ES110 sheet)

1.19 OPERATING INSTRUCTIONS AND SERVICE MANUALS

.1 Upon completion of the installation, provide two (2) complete and comprehensive identical hard copy sets of operating and maintenance manuals. Provide one (1) Portable Document Format (PDF) electronic copy of the maintenance manual.

.2 The Consultant shall review the operating and maintenance manuals and approve same prior to the manuals being sent to the Owner.

.3 The operating and maintenance manuals shall include but not be limited to the following information when applicable in the project:

.1 Certification reports.
.2 Documentation indicating Owner's receipt of operating instructions.
.3 Complete list of all materials turned over to the Owner c/w receipts for same.
.4 Shop drawings properly indexed and contained in suitably sized binders.
.5 Schematic drawings for all systems indexed and contained in suitably sized envelopes or attached efficiently in the above binders.
.6 Catalogue brochures for light fixtures, panelboards, switches, receptacles, fuses, etc.
.7 All final settings of equipment that has user adjustable settings.
.8 Certificate of Owner's training.
.9 Acceptance Testing and Commissioning reports.

The above information shall be bound in binders as noted in specifications. Incomplete or poorly reproduced manuals will be rejected.

.4 Maintain, on a daily basis, a complete set of marked-up prints as as-built drawings that show in complete detail the final arrangement and location of all electrical components and the interconnecting wiring.

.5 All riser conduits (size and routing), panel feeds (size and routing), conduit runs (size and routing) and main communications (size and routing) shall be marked on plans. These are to be maintained in a neat and substantial manner, so as to properly and fully illustrate the way in which the installation has been completed.

.6 All equipment locations such as fire alarm signal boosters, cable termination boxes, signal amplifiers, network switches, door controllers, etc shall be identified on the drawings as to their location and quantity (if more than one exists at that particular location).

.7 The Owner's personnel shall be instructed in the operation and maintenance of the following equipment to the satisfaction of the Owner as per the standards referenced herein.

Section No.	Description	Hours
26 50 00	Lighting	1

.8 The above instructions shall be given by personnel experienced in the operation of the particular system or equipment. Each item or type of equipment, and all controls, shall be operated in the presence of the Owner's personnel to ensure their understanding of equipment function and individual working parts. The Owner reserves the right to set the period or periods during which the instruction shall be given. The contractor shall submit a program of instruction for approval by the Owner.

.9 Operating and maintenance manuals shall include written documentation bearing name and signature of Owner's personnel who received the above instructions. Contractor shall allow for all training to be completed in a minimum of two sessions. One session at substantial completion and one session within three months of turning over the system.

.10 Operating and maintenance manuals, as well as all Owner instructions, shall be complete before substantial completion (as outlined by the Builders' Lien Act) will be considered. Also, preliminary maintenance manuals must be submitted prior to 70% completion. No further progress payments will be permitted until these preliminary maintenance manuals have been submitted and approved.

1.20 STORAGE AND PROTECTION

.1 Maintain and protect all work provided under this Division. Store all materials within a protected enclosure to prevent exposure to weather or construction dirt.

.2 Protect all finished and unfinished work of this and other divisions from damage during the course of construction. Cover floors and other surfaces, if necessary. Any damaged work or finishes shall be repaired or replaced without further charge to the Owner.

1.21 WARRANTY

.1 All materials and workmanship shall be guaranteed for a period of one year from date of substantial completion.

.2 Properly repair and replace all defective work and other work which becomes defective during the term of warranty.

.3 Service on equipment or systems critical to the Owner's operation shall be provided on an emergency basis which may necessitate overtime and service outside of normal working hours. The contractor shall ensure that all suppliers comply with this requirement.

1.22 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

.2 Control wiring and conduit is provided by the Electrical Contractor except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 15 and shown on mechanical drawings.

1.23 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 switchboards and distribution enclosures light grey ASA 61.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

1.24 ABBREVIATIONS

.1 Abbreviations used in this specification are common to and in general use within the related trades.

1.25 EQUIPMENT IDENTIFICATION

.1 Nameplates shall be provided on each new piece of electrical equipment, including, receptacle coverplates, power panels, distribution panels, lighting panels, transformers, disconnect switches, contactors, telephone panels, miscellaneous systems and panels.

.2 Nameplates for each new electrical panel shall indicate panel designation, mains voltage and panel and circuit number from which this panel is fed.

.3 Nameplates for new disconnects and contactors shall indicate equipment being controlled, and voltage.

.4 Nameplates for new terminal cabinets shall indicate system and voltage and load of area served.

.5 Nameplates for Normal Power Equipment shall be made from black-white-black Lamecoid with bevelled edges and white engraved letters. Nameplates shall be fastened with self tapping metal screws to equipment in a conspicuous location. Flush mounted panels shall have nameplate located on front of panel behind hinged door.

.6 Typical identification standards shall be used for new equipment throughout the project as follows:

.1 Receptacle coverplates shall be identified with an engraved coverplate secured to the outlet box as follows:

.1 Circuit number in 5 mm high letters

.2 Lighting, receptacle and power panels shall each be identified with an engraved Lamecoid plate secured to top interior trim as:

Panel 202	10 mm high lettering
120/208 volts	6 mm high lettering
Fed from	6 mm high lettering

.3 Each panel shall be supplied with a directory card holder welded to inside of door, complete with a neatly typewritten list showing information as follows:

Panelboard name	202
Panel voltage	120/208 volts

Circuit Number	Description	Load
1	Lighting Room 200 (Main Area)	1200W
2	Receptacles Room 200 (Main Area)	6-15A
3	Room 220	1/3 H.P. Fan

Spaces and spares shall be left blank so as to facilitate future description. Also, existing panels where adjustments have been made in the circuitry shall be field checked in their entirety and new updated directory cards shall be provided.

.4 List shall be covered with a 1 mm thick clear plastic sheet to protect it.

.5 Other cabinets and plywood back boards for low voltage systems, such as signals and communications, shall be identified as panelboards with a directory showing circuit numbers and room locations, plus a blank for "Remarks", as well as a Lamecoid plate designation panel name.

EXAMPLE: if cabinet is for telephone

.....TP - 2nd floor

.6 Equipment not listed above, such as incoming service cables, communicating cables, switchgear, transformers, disconnects, motors, instruments, fire alarm and control panels, shall be identified in a similar manner, showing name and number of the equipment, voltage and load information.

.7 Feeder pull boxes and junction boxes shall be identified with waterproof ink, showing feeder or system concerned. Conduit entering junction boxes for communications systems shall be identified with the room number that each conduit serves.

.8 A small dab of paint shall be applied to inside of each outlet box, pull box and panel as it is installed, using colour code as follows:

Red	-	Fire Alarm System
Yellow	-	Security, Alarm Systems, Card Access

Green - Telephone/IT Computer Systems

The outside of the box shall also be identified in this way so as to readily determine the system within the conduit system. The cover of each junction box for branch circuits shall describe the voltage being used by means of a waterproof ink.

.9 No colour code is required for regular lighting and power circuits, but voltage class shall be displayed on all pull boxes and panels.

.10 Junction boxes in furred ceilings shall be colour identified on both inside and outside.

.11 Connections in equipment shall be made Phase 'A', 'B', 'C', from left to right when viewing wiring from front or accessible direction.

.12 Colour coding shall be carried through from incoming utility supply down to and including panels, and shall be as follows:

.1 Incoming utility service lines shall be identified by Red - Phase 'A'; Black - Phase 'B'; Blue - Phase 'C'; with colour coded PVC tape.

.2 Switchgear buswork in each switchboard and unit substation cubicle shall be banded with 3M tape identified in accordance with service lines colour coding. In addition, where neutral bus is introduced, it shall be banded white. Ground bus shall be banded green.

.3 Feeder and sub-feeder bus or conductors shall be banded as above.

.4 Lighting and power panels shall conform to the Canadian Electrical Code, and shall have main bus banded with tape as follows:

Red	-	Phase 'A'
Black	-	Phase 'B'
Blue	-	Phase 'C'
White	-	Neutral
Green	-	Ground

.13 The circuits controlled by all light switches shall be neatly printed with waterproof ink on the side of the switch outlet box so that the panel and circuit number are clearly legible when the coverplate is removed. It shall not be necessary to remove the switch from the outlet box in order to read the panel or circuit number.

1.26 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, either numbered or 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 code: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

1.27 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

1.28 WIRING TERMINATIONS

.1 Lugs, terminals, screws used for termination of wiring to be suitable for either copper or aluminum conductors.

1.29 MANUFACTURERS AND CSA LABELS

.1 Visible and legible, after equipment is installed.

1.30 WARNING SIGNS

.1 As specified and to meet requirements of Electrical Inspection Department and Owner.

.2 Decal signs, minimum size 175 x 250 mm.

1.31 LOCATION OF OUTLETS

.1 Locate outlets in accordance with drawings and specifications.

.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. Locate disconnect devices in mechanical and electrical on latch side of door.

1.32 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 or as noted on drawings.

.1 Local switches: 1200 mm.

.2 Wall receptacles:

.1 General: 450 mm.

.2 Above top of counters or counter splash backs: 150 mm.

.3 In mechanical rooms: 1400 mm.

.3 Fire alarm stations: 1200 mm.

.4 Fire alarm horn/strobe: 2100 mm.

1.33 LOAD BALANCE

.1 All lighting panels, distribution centres, motor control centres and main switchboards shall be load balanced such that the maximum variation between the two worst phases does not exceed 5%.

.2 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.

.3 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.4 Submit, at completion of work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

1.34 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete. Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings to be embedded or plastered over, neatly and close to building structure so furring can be kept to minimum.

.4 All conduit and tray sealing shall be the responsibility of the Electrical Contractor.

1.35 TEMPORARY AND TRIAL USAGE

.1 Temporary and trial usage by the Owner, or the Contractor, of any of the electrical apparatus or equipment, or any work or materials supplied under this Division before final completion and written acceptance, is not to be construed as evidence of acceptance of same by the Owner.

.2 Temporary and trial usage may be made as soon as this Division deems the work sufficiently advanced for making a complete and thorough test of same, and that no claim may be made for the injury to or the breaking of any part of such work which may be so used, whether caused by weakness or inaccuracy of structural parts, or by defective material or workmanship of any kind.

.3 Lighting shall not be used for temporary or trial usage without prior approval of the owner and consultant sign off. If temporary lighting is required for the duration of the project, only construction lamps marked with a permanent ink on the lamp may be used. Evidence of marking will be requested by the consultant. Any fixtures used for temporary or trail usage shall be relamped and cleaned. Evidence of cleaning and relamping will be required by the consultant.

1.36 TEMPORARY LIGHT AND POWER

.1 The General Contractor shall be responsible for all temporary light and power provisions. Refer to General Conditions.

1.37 MATERIAL TO BE TURNED OVER TO THE OWNER

.1 All equipment that is being removed or replaced shall be stockpiled as per Owner's request. The owner may deem that the equipment shall be disposed. All disposal and removal is the responsibility of the contractor.

.2 Materials as indicated in various sections of this specification shall be turned over to the Owner. These materials shall include, but not be limited to the following:

.1 Obtain a signed receipt for each item turned over to the Owner. Include receipts in the operating and maintenance manuals.

1.38 SITE EXAMINATION

.1 The contractor shall visit the existing site during the tendering period to familiarize himself with the construction conditions and electrical work provided to date. The contractor shall thoroughly satisfy himself that the work contained in these drawings and specifications can be carried out and that all costs have been included in the tender submitted.

1.39 CUTTING AND PATCHING

.1 Should any cutting or repairing of either unfinished or finished work be required, the contractor shall employ the particular trade whose work is involved, to do such cutting and patching, and shall pay for any resulting costs.

.2 All holes within buildings shall be fire stopped when penetrating a fire rated structure.

1.40 PAINTING

.1 All iron or steel structures fabricated and installed by Divisions 26, 27, and 28 for supporting panels, starters, conduit or other equipment, shall be wire brushed and given one coat of lead chromate paint primer before being set into place. After all equipment is installed and piping complete, this iron work shall be given two coats of ASA #61 enamel to match the panel or structure being supported or in the colour specified for the product.

.2 All pull boxes, wireways, gutters, etc., fabricated for Divisions 26, 27, and 28, shall be given a coat of primer and two coats of ASA #61 enamel before installation to match equipment finish.

.3 All panels and pull boxes that are set in finished walls or ceilings shall have approved flush covers that shall be prime coated paint, and left for the painting division to paint in with the surrounding wall or ceiling finishes. Panel trims and pull box covers to be painted with the cover removed from the wall so that it can be easily installed or removed without damaging the surrounding paint finish.

.4 All electrical equipment shall be finished with an ASA #61 enamel, the colour of which shall be grey, unless otherwise specified.

.5 When installation is complete, all scratches and defects to the paint finishes shall be properly touched up, and where necessary, entire paint surfaces shall be re-done.

1.41 MATERIAL SAFETY DATA AND HAZARDOUS MATERIALS

.1 The Contractor shall provide material safety data sheets on all materials prior to shipping materials to site. These data sheets shall be submitted in triplicate to the Owner.

.2 The Contractor shall coordinate and provide necessary information for the Owner's "Work Place Hazardous Material Information System".

1.42 SCHEDULING OF WORK AND DEMOLITION

.1 Refer also to Division 1 specifications.

.2 The contractor shall make a thorough study of the main distribution and communications systems to ensure the method required to maintain all existing building services during the construction period. All changeovers shall be done during a period of the day found satisfactory to the Owner.

.3 All outages shall be less than two (2) hours in duration. The contractor shall submit the method and procedure of all changeovers for approval by the Consultant and the Owner a minimum of fifteen (15) working days in advance. The Contractor shall anticipate all power outages and change-over to be performed during weekends.

.4 The existing data and voice communication systems, building security system and fire alarm system shall be maintained in a fully operational state while modifications and additions to the systems are installed. Outages of minimal duration possible shall be permitted for the purpose of cutting over new portions of the system.

.5 All outages of systems shall be carried out at dates and times approved by the Owner.

.6 After the modifications to the existing data and voice communications systems, building security system and fire alarm system are complete, any unused portions of the existing systems shall be removed.

.7 Division 26 shall be responsible for the demolition of all existing lighting, electrical systems, communication systems and fire alarm system within the renovation areas. All abandoned conduit, wire and cable (existing conditions and as a result of the renovation work) shall be removed.

.8 All existing power and communication cabling that is found to be abandoned or becomes abandoned within the renovation area, shall be completely removed within the renovation space, as well as back to the source or origin.

All salvaged materials shall remain the property of the Owner, unless otherwise noted, and shall be stockpiled as per the Owner's instructions. The salvageable materials shall be removed for the purpose of reuse, and shall be returned as per the Owner's instructions.

.9 Refer to the overall project schedule for further scheduling requirements.

1.1 NOT USED

.1 Not Used.

Part 2 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

CONTRACTOR PROGRESS REPORT ES110

Ritenburg & Associates Ltd.
Consult ng Electrical Eng neers

#200–2222 ALBERT STREET – REGINA, SASK. S4P 2V2
Phone: (306) 569–1303 Fax: (306) 569–1307

ELECTRICAL PROGRESS CLAIM No. _____
DATE _____ 20____
PROJECT _____
ELECTRICAL CONTRACTOR _____
GENERAL CONTRACTOR _____
PRIME CONSULTANT _____
SUBMITTED BY _____

REVIEWED BY: _____
DATE: _____ 20____

RECOMMENDED PAYMENT AS SHOWN ☐ AS CORRECTED ☐ REJECTED ☐

* Cross out if not applicable	TOTAL CONTRACT		COMPLETE TO DATE		THIS PROGRESS	
	MATERIAL	LABOR	MATERIAL	LABOR	MATERIAL	LABOR
A. MAIN SERVICE *HV, Duct Bank, Trans–formers, Switchboards						
B. DISTRIBUTION / PANELS *Distribution Centres, Dry Type Transformers, Fuses						
C. CONDUIT AND BOXES *Tray						
D. WIRE AND CABLE *Bus Duct						
E. MOTOR CONTROL						
F. WIRING DEVICES *Dimmers, Pac Poles, Low Voltage Switching, Cover–plates						
G. LIGHTING FIXTURES & LAMPS						
H. ALARM SYSTEMS *Fire, Security, Signal, Medical						
I. COMMUNICATIONS SYSTEMS *Intercom, Nurses' Call, Data/Telephones						
J. SPECIALS *Emergency Generator, Lightning Protection CCTV, UPS, Trench Duct						
K. MISCELLANEOUS – 8% Maximium						
L. EXTRAS & CREDITS (List price changes seperately, use separate sheet if necessary)						
TOTAL						

SUMMARY TOTAL	Contract $	To Date $	This Progress
	Contract GST $	To Date GST $	This Prog GST $
	Total Amount	Less Holdback	Less Holdback
		Net Amount	Net Amount

% COMPLETE _____

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 26 05 01 – Common Work Results

.2 Shop drawings shall include but not be limited to device types, cable types, and special mounting details.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 MATERIALS

.1 Pressure type wire connectors: with current carrying parts of copper sized to fit copper conductors as required.

.2 Fixture type splicing connectors: with current carrying parts of copper sized to fit copper conductors #10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for round copper conductors.

.2 Clamp for round copper conductors.

.3 Stud clamp bolts.

.4 Sized for conductors as indicated.

.4 Clamps or connectors for armoured cable, aluminum sheathed cable, mineral insulated cable, flexible conduit, non-metallic sheathed cable as required.

Part 3 Execution

3.1 INSTALLATION

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2No.65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

.4 Install bushing stud connectors in accordance with NEMA.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 RELATED SECTIONS

.1 Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

1.3 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-12, Canadian Electrical Code, Part 1, 2012
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE)
.7 Audio Engineering Society (AES)
.8 CSA C22.2 No. 0.3-96, Test Methods for Electrical Wires and Cables
.9 CAN/CSA-C22.2 No. 131-M89(R1994), Type TECK 90 Cable
.10 Other Applicable CSA and UL approvals.

1.4 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 26 05 01 – Common Work Results

.2 Shop drawings shall include manufacturer of the cable indicating type, voltage rating, ampacity, conductor and insulation level.

1.5 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

□

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 BUILDING WIRES

.1 All conductors shall be copper, minimum No. 12 gauge, unless specifically noted otherwise.

.2 Conductors shall be rated as follows:

.1 #12 AWG to #8 AWG: minimum 600V RW90 XPLE

.2 #6 AWG and larger: minimum 1000V RW90 XPLE

.3 Conductors from motor to variable frequency drives, and from variable frequency drive to source: minimum 1000V RW90 XPLE

.4 Wiring in channel back of fluorescent fixtures shall be 600 volt Type GTF or TEW.

.5 Circuit conductors: copper, size as indicated.

.3 Size, grade of insulation, voltage and manufacturer's name shall be marked at regular intervals.

.4 1000V RWU90 XLPE conductors may be substituted for 1000V RW90 XLPE conductors provided that the conduit size is sized in accordance with the Canadian Electrical Code.

.5 Wiring for feeders 100 amps or larger may be NUAL aluminum and shall be installed only where specifically noted on the drawings.

.6 Conductor utilized in conduit run under slab on grade or in underground conduit shall be Type ‘RWU-90’.

.7 Wire shall be as manufactured by Alcan, BICC General Wire, Nexans or Superior Essex.

2.2 TECK CABLE

.1 Cable: to CAN/CSA-C22.2 No. 131.

.2 Conductors:

□

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.3 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600V to 1000V as noted above.

.4 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables.

.3 Threaded rods: 6 mm dia. to support suspended channels.

.5 Connectors:

.1 Watertight, approved for TECK cable.

.6 Teck Cable as manufactured by Alcan, BICC General Wire, Nexans or Superior Essex.

2.3 ARMOURED CABLE

.1 Conductors: insulated, copper, size as indicated

.2 Type: AC90

.3 Armour: interlocking type fabricated from galvanized steel strip.

.4 Type: ACWU90

.5 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

2.4 FIRE RATED CABLES

.1 Conductors: Solid bare soft-annealed copper, single or multi-conductors sized as indicated.

.2 Insulation:

.1 Mineral Insulated Cable: Compressed powered magnesium oxide to form compact homogeneous mass throughout entire length of cable

.2 MC Cable: Ceramifiable silicon insulation

.3 Overall covering:

.1 Mineral Insulated Cable: Annealed seamless copper sheath, Type MI rated 600-volt.

□

.2 MC Cable: Ceramifiable silicon rubber bedding layer

.4 Cable and Terminations Temperature Ratings: 90°C, 600 Volt

.5 Outer Jacket:

.1 Mineral Insulated Cable: None required

.2 MC Cable: Continuously welded and corrugated copper armour

.6 Fire Rating: Certified to UL 2196 "Tests for Fire Resistvie Cable" to meet two hour rating and listed by Underwriters Laboratories of Canada.

.7 Manufacturers

.1 Mineral Insulated Cable manufactured by Pyrotenax

.2 MC 2-hour rated power cable manufactured by VITALink MC

.8 Terminations/Connectors:

.1 All mineral insulated metal sheathed cables shall be terminated and spliced with compression type connectors, as recommended and supplied by the cable manufacturer. The connectors shall satisfy the bonding and grounding requirements at the supply end.

.2 VITALink MC Cables: Use brass MC Connectors suitable for corrugated copper sheath cable as manufactured by one of the following:

Copper Crouse-Hinds 'TMC' series
Hubbell Killark Electric 'MCR' series
Thomas & Betts 'STE' series

.9 Alternative construction methods in lieu of the specified fire rated cables will not be accepted.

Part 3 Execution

3.1 INSTALLATION OF BUILDING WIRES

.1 All 120/208 volt receptacle and lighting circuits that exceed 30 metres in length from the panel shall be fed with #10 AWG conductors.

.2 All branch circuit conductors shall be sized to limit the voltage drop to a maximum of 3% based on the circuit load of 80% of the circuit protective device.

.3 Termination for #8 AWG and larger shall be by means of approved solderless connector lug. For parallel conductors, a common lug with separate termination for each conductor shall be employed.

.4 Conductor splices shall be made in accordance with specifications. Provide sufficient length for joint remake, and no less than 200 mm spare length. On through wiring, leave 300 mm loop.

□

.5 Wiring in cabinets, pull boxes, panels and junction boxes shall be neatly trained and held with nylon cable ties.

.6 Conductors shall be tag identified where passing through junction boxes.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

.1 Install cables.

.2 Group cables wherever possible on channels unless specifically noted otherwise.

.3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0-1000V.

.4 All cables shall be terminated and spliced with suitable compression type connectors, as recommended by the cable manufacturer. The connectors shall satisfy the bonding and grounding requirements at the supply end.

.5 All cables shall be single conductor and copper, unless otherwise specified.

.6 All cable shall be rated for 1000 volts, insulated with cross-linked polyethylene and rated for operation at 90 degrees C. Cable shall have a FT4 rated outer jacket.

.7 All cable shall meet the CSA requirements for cold bend and impact testing at minus 40 degrees C.

.8 All cable shall be protected by a corrugated aluminum sheath or by interlocked aluminum armour. PVC jackets shall be required on all metallic sheathed cables.

.9 The jackets shall meet the FT4 flame spread requirements and be identified on the P.V.C. jacket.

.10 All cables shall be installed in accordance with the manufacturers recommendations, in suitable cable tray as specified within the specifications.

.11 The cables shall be terminated at the supply end on a non-ferrous metallic plate and at the load end on a non-metallic rigid fibre board plate. The cable sheaths shall be bonded at the supply end only.

.12 All cable installed in cable tray shall be installed at one diameter spacing.

.13 When single conductor cables are direct earth buried they shall be spaced 150 mm apart.

3.3 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible.

.2 Armoured cabling may only be installed for motor connections, lighting runs from ceiling to junction boxes, or where noted on plans.

.3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors – 0 - 1000V.

.4 Conductors: insulated, copper, size as indicated.

□

.5 Type: AC90 - Armour: interlocking type fabricated from aluminum strip.

.6 Type: ACWU90 - jacket over armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

.7 Connectors: as required.

.8 Multi conductor cables shall be color coded during manufacture. Single conductor cables shall be color coded adhesive colour coding tape. The tape shall be applied for a minimum of 75mm at all terminations. Cables shall not be painted under any condition. Color coding shall be as follows:

Phase 'A' – RED	Neutral - WHITE
Phase 'B' – BLACK	Ground – GREEN or Bare
Phase 'C' – BLUE	

3.4 INSTALLATION OF FIRE RATED CABLES

.1 Cables shall be shipped from the manufacturer with ends temporarily sealed against moisture egress. Cable shall be stored in a clean dry location.

.2 When cables are cut in the field, the end shall be sealed by means of standards sealing compound and PVC tape.

.3 Installation of fire rated cables shall be in accordance with the manufacturer's installation instructions.

.4 Bending:

.1 Mineral Insulated Cable: no less than six (6) times the cable diameter for cable not more than 250 MCM.

.2 MC Fire Rated Cable: as per manufacturer's requirements.

.5 Pulling: In accordance with the manufacturer's installation instructions.

.6 Splicing: In field splices will not be accepted.

.7 Exposed or surface installations;

.1 Secure direct to fire rated building structure

.2 Straps: Stainless steel or copper straps

.3 Steel struts or Cable Tray: Aluminum or other materials not acceptable.

.8 Fire rated cables shall not contact sprinkler lines, EMT conduit or rigid steel conduit. Do not support fire rated cables to sprinkler lines and conduit.

.9 Use of nylon cable ties to support fire rated cables will not be accepted.

□

.10 Through wall or floor penetrations:

.1 Install sleeve to protect cable.

.2 Apply approved fire stopping of all penetrations.

.11 Support 2-hour rated cables at 1 meter intervals (maximum) for both horizontal and vertical runs. Run parallel to building lines.

.12 Make cable terminations by using factory-made kits.

.13 At cable terminations, use thermoplastic sleeving over bare conductors.

.14 Where cables are buried in cast concrete or masonry, sleeve for entry and exit of cables.

.15 Do not splice cables.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 Audio Engineering Society (AES).

.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Shop drawings shall include but not be limited to connectors used, specialty ground bars, etc.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

□

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 EQUIPMENT

.1 Clamps for grounding of conductor: size as required to electrically conductive underground water pipe.

.2 All ground rods shall be 20 mm diameter by 3000 mm long, copper clad.

.3 Grounding conductors: bare stranded copper.

.4 Insulated grounding conductors: green

.5 Ground bus: copper, complete with insulated supports, fastenings, connectors.

.6 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 Thermit welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

.7 All ground conductors shall be bare or insulated, stranded, medium hard drawn copper wire. All insulated ground wires shall be green.

.8 Exposed copper shall be cleaned to a bright surface, and shall be finished with two coats of clean, insulating varnish.

.9 Connect ground conductor to copper water pipe at least twice (minimum 40 mm diameter), utilizing a Burndy Type GAR pipe clamp. Provide jumper across water meter.

.10 All connections to the ground bus or risers shall be thermowelded, or shall utilize the Burndy Hy-Ground compression connections. Clamp type connections shall only be allowed to individual pieces of equipment.

□

.11 Where bonds are covered with soil, the conductors are to be coated with anti-corrosion compound "Kopr-Shield" (Thomas & Betts Co.) before compression connector is applied. All bonding shall be done with 'C' tap and lug compression connectors.

Part 3 Execution

3.1 INSTALLATION GENERAL

.1 Electrical equipment and wiring shall be grounded in accordance with the Canadian Electrical Code, and local inspection authority's rules and regulations.

.2 All metallic raceways and conduits for communications, cable and conductors shall be grounded.

.3 All motors with flexible connections shall have separate ground wire run bridging the flexible connections. This ground wire shall be run from the motor back to the nearest junction box or motor control centre where the termination can be readily inspected. Insulation for this wire shall be green.

.4 Lay-in trays and feeder conduits shall be connected to the ground bus.

.5 All panel feeds at 208 volt shall include a building network ground conductor.

.6 All grounding conductors outside the electrical rooms and closets shall be insulated and installed in conduits, unless otherwise noted.

.7 Install connectors in accordance with manufacturer's instructions.

.8 Protect exposed grounding conductors from mechanical injury.

.9 Use mechanical connectors for grounding connections to equipment provided with lugs.

.10 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.

.11 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.12 Structural steel and metal siding to ground by welding copper to steel.

.13 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections unless indicated otherwise.

.14 Use mechanical connectors for grounding connections to equipment provided with lugs.

.15 Soldered joints not permitted.

.16 Install separate ground conductor to outdoor lighting standards.

.17 Make grounding connections in radial configuration only. Avoid loop connections.

□

.18 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.2 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of secondary systems.

3.3 EQUIPMENT GROUNDING

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, duct systems, frames of motors, starters, control panels, structure steel work, and distribution panels.

3.4 COMMUNICATION SYSTEMS

.1 Install grounding connections for all communication and security systems as per manufacturer's recommendations

3.5 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Perform tests before energizing electrical system.

.3 Disconnect ground fault indicator during tests.

.4 All grounding conductors outside the electrical rooms and closets shall be insulated and installed in conduits, unless otherwise noted.

.5 Connections to equipment shall be made with, bronze or copper bolts and connectors.

.6 Equipment grounds shall be connected to the building grounding network. All non-current carrying metallic parts of equipment shall be connected to the ground network.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 Audio Engineering Society (AES).

.8 Other Applicable CSA and UL approvals.

.2 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

1.3 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

□

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended or set in poured concrete walls and ceilings.

Part 3 Execution

3.1 INSTALLATION

.1 Secure equipment to poured concrete with expandable inserts.

.2 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.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 dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.7 For surface mounting of two or more conduits, use channels spaced as required by C22.1.

.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 Engineer.

.12 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

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.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 SPLITTERS

.1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three spare terminals on each set of lugs in splitters.

2.2 JUNCTION AND PULL BOXES

.1 Welded steel construction with screw-on flat covers for surface mounting.

.2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

.1 Sheet steel, hinged door and return flange overlapping sides, handle, lock and catch, for surface mounting.

Part 3 Execution

3.1 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information for incorporation into manual specified in:

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.2 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

3.2 SPLITTER INSTALLATION

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.3 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

.1 Install pull boxes in inconspicuous but accessible locations.

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.2 Mount cabinets with top not higher than 2 m above finished floor.

.3 Install terminal / bix block where indicated in cabinets.

.4 Only main junction and pull boxes are indicated. Provide others as required by code. Install pull boxes so as not to exceed 30m of conduit run between pull boxes.

3.4 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 2 identification labels indicating system name, voltage and phase, Emergency, or Normal power.

3.5 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 26 05 01 – Common Work Results

.2 Shop drawings shall include but not be limited to speakers, riser diagram, cable types, and special mounting details.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

□

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

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 for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Provide blank cover plates for boxes without wiring devices.

.5 Provide combination boxes with barriers where outlets for more than one system are grouped.

.6 Each outlet box installed in steel stud and gyproc walls shall be mounted on Caddy #BHA, series SGB or TSGB screw gun brackets. Wood strapping with steel studs shall not be utilized for supporting outlet boxes

.7 Use condulets where 90° turn required on wall mounted conduit. They shall be of the type where cover screws do not enter the wire chamber and covers are left accessible.

.8 Each outlet box installed in acoustic tile ceilings shall be mounted on double Caddy "Tee Bar Hanger" #512 in such a manner that the outlet box will not twist in any direction.

.9 Where boxes are surface mounted in unfinished areas, such as furnace or boiler rooms, stamped galvanized steel 100 mm square box to accept #8300 series raised covers shall be used.

.10 Where surface wiring methods are allowed and approved in finished areas, use Hubbell or Wiremold boxes as per drawings c/w suitable adapter for wireway entrance.

.11 Outdoors or damp locations, boxes shall be cast Feraloy or aluminum type 'FS', with threaded hubs and vapourproof covers.

.12 Indoors, stamped zinc cadmium plated steel boxes shall be provided and set for each fixture, switch, wall receptacle or other types of outlets, adapted to suit its respective location and designed to accept its particular components.

.13 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.14 Two gang or larger shall be solid type with raised cover for tile, block or gyproc finish.

.15 Wood strapping with steel studs shall not be utilized for supporting outlet boxes.

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.16 Set boxes plumb and level within 6 mm of finished surface. Mats not permitted.

.17 Where required, provide voltage separation barriers.

2.2 SHEET STEEL OUTLET BOXES

.1 Electro-galvanized steel 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.

.2 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.3 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished walls.

.4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster walls.

2.3 MASONRY BOXES

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.4 CONCRETE BOXES

.1 Electro-glavanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.5 CONDUIT BOXES

.1 Outdoors or damp locations, boxes shall be cast Feraloy or aluminum type 'FS', with threaded hubs and vapourproof covers.

.2 Indoors, stamped zinc cadmium plated steel boxes shall be provided and set for each fixture, switch, wall receptacle or other types of outlets, adapted to suit its respective location and designed to accept its particular components.

.3 Standard octagon boxes shall be 100 mm diameter, 53 mm deep minimum. Increase depth where area fill requires. Equip each box used for fixture hanging with a fixture stud.

.4 Two gang or larger shall be solid type with raised cover for tile, block or gyproc finish.

.5 Wood strapping with steel studs shall not be utilized for supporting outlet boxes.

.6 Set boxes plumb and level within 6 mm of finished surface. Mats not permitted.

.7 Where required, provide voltage separation barriers.

2.6 FITTINGS - GENERAL

.1 Bushing and connectors with nylon insulated throats.

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.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 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. Reducing washers are not allowed.

.5 Outlet boxes shall be supported independently of conduit capable of supporting weight of fixture or other device. Conduit entering the back of a box shall not enter the centre knockout.

.6 For recessed fixtures in suspended ceilings, outlet box shall be accessible when fixture is removed.

.7 Flexible conduit to fixture shall be minimum 12 mm diameter, and shall not emanate from outlet box cover. Maximum length of flexible conduit from outlet box to fixture shall be 3000 mm. Outlet box for fixture shall not be located above ducts, pipes, etc. Outlet box shall be within 750 mm (vertically) of the fixture.

.8 Provide and set all special communications type back boxes associated with systems specified under Electrical Divisions.

.9 In placing outlets, allow for overhead pipes, ducts, etc., and for variation in wall and ceiling finishes, door and window trim, panelling, etc.

.10 Location of receptacle outlets in equipment rooms shall be finalized during construction to give optimum arrangement. Consultant to approve locations before installation.

.11 Multigang boxes shall have each gang fully barriered from the next, or multiple single gang boxes may be used, provided they are installed in a neat, orderly fashion. Barriers shall be steel and shall be firmly held in place.

Attention is directed to special outlet box locations for switches requiring wider mount spacing rejection feature.

3.2 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information for incorporation into manual specified in:

□

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 Operation instructions

.2 Description of system operation

.3 Description of each subsystem operation

.4 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.5 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

3.3 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

□

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

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.

.4 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3

.5 Conduit for use in corrosive atmospheres shall be rigid PVC or rigid steel with extruded PVC jacketed. Refer to drawings for areas requiring PVC.

.6 Condulets shall be of a type wherein cover screws do not enter the wire chamber.

.7 Flexible conduit connections to all mechanical equipment shall be of 'Sealtite' manufacture.

.8 Flexible conduit connectors shall be of the insulated throat type.

.9 Condulets with suitable covers shall be used where condulets are exposed. Each conduit fitting shall be of a type suitable to its particular use, and of a type which will allow installation of future conduits without blocking covers of existing condulets.

.10 Expansion joints shall be installed with ground jumper.

.11 All conduits shall be terminated with a suitable bushing.

.12 Flexible conduit and Rigid conduit entering boxes or enclosures shall be terminated with nylon insulated steel threaded bushings, grounded type.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. 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 oc.

.4 Threaded rods, 6 mm dia., to support suspended channels.

2.3 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit / raceway specified. Coating: same as conduit / raceway.

.2 Factory "ells" where 90º bends are required for 25 mm and larger conduits / raceways.

□

2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.5 FISH CORD

.1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

.1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.2 Conduits and cables shall be supported, at regular intervals, with corrosion resisting clamps. Lead anchors or expansion bolts shall be used to attach clamps to masonry walls.

.3 Conduit and cables shall be installed to avoid proximity to water and heating pipes. They shall not run within 150 mm of such pipes, except where crossings are unavoidable, in which case they shall be kept at least 25 mm from covering of pipe crossed.

.4 Cap ends of all conduits to prevent entrance of foreign matter during construction. Manufactured caps shall be employed.

.5 Conduit shall be installed as close to building structure as possible so that where concealed, necessary furring can be kept to a minimum.

.6 Empty conduits, installed under this Division but in which wiring will be installed by others, shall be swabbed out with "Jet Line" foam packs, and be c/w Polypropylene pull wire or polytwine.

.7 Conduits shall be installed at right angles or parallel to building lines, accurate in line and level.

.8 Conduit shall not be bent over sharp objects. Improperly formed bends and running threads will not be accepted. Bends and fittings shall not be used together. Proper supports of manufactured channels shall be provided where exposed conduits and cable runs are grouped.

.9 Under no condition will EMT be allowed exposed within 1200 mm of floor, outdoors, or in areas where explosive, corrosive or moist atmosphere exists.

.10 Not more than four (4) 90 degree bends or equivalent offsets will be permitted between pull boxes. When maximum number of bends are used, the total run between pull boxes shall not exceed 18000 mm.

□

.11 PVC conduit shall not pass through a fire partition or floor separation. Where it is necessary for PVC conduits to pass through a fire barrier, a transition to rigid steel conduit shall be provided for 2000 mm on either side of the fire barrier.

.12 Surface mount conduits except where noted otherwise.

.13 Use rigid PVC conduit in corrosive areas or as indicated on plans.

.14 Use flexible metal conduit or Teck90 for connection to motors.

.15 Use liquid tight flexible metal conduit or Teck90 for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.16 Use explosion proof flexible connection for connection to explosion proof motors.

.17 Minimum conduit size for lighting and power circuits: 19 mm.

.18 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter. Mechanically bend steel conduit over 19 mm dia.

.19 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.20 Install pulltwine in all empty conduits / raceways and conduits / raceways that are less than 40% filled.

.21 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.22 Dry conduits out before installing wire.

.23 Conduits/Cabling/raceways are not to be run within concrete floors/ceilings. Any conduits/cabling/raceways required to be run along the concrete slabs shall be surface run and not recessed into the concrete. Any instances where cabling is required to be run vertically within concrete poured walls, coreline may be used as the raceway but it shall be transitioned to EMT or Rigid Steel (where required) with interfacing connectors or junction boxes being provided as required. This specification contains references to cast in place conduits. This is only applicable where specifically called for in certain locations within the documents.

3.2 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 surface 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.

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3.3 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.

3.4 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

3.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information for incorporation into manual specified in:

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.2 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

3.6 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

.3 Section 01 33 00 - Submittal Procedures.

.4 Section 01 74 19 - Construction/Demolition Waste Management And Disposal.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA C22.2No.126-M91(R1997), Cable Tray Systems.

.2 National Electrical Manufacturers Association (NEMA) standards

.1 NEMA FG 1-1993, Fibreglass and Cable Tray Systems.

.2 NEMA VE 1-1998, Metal Cable Tray Systems.

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Identify types of cabletroughs used.

.3 Show actual cabletrough installation details and suspension system.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 CABLETROUGH / CABLE TRAY

.1 Provide solid cable tray and basket style cable tray in widths and locations noted on drawings.

.2 Cable trays shall be complete with necessary factory elbows, fittings, joiner plates, radius turns, supports, etc., as necessary for the total installation.

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.3 Cable tray shall be provided for communications conductors where shown on the drawings. The cable tray shall be used for the running of data/voice communications cables, coax cable.

.4 The cable tray shall not be used for the running of low-voltage Class 2 control wiring.

.5 Solid cable tray shall be 12 to 18 gauge steel construction, minimum of 105mm deep, 305mm or 450mm widths as noted on the drawings, in standard 3048mm lengths, with hinged or clip-on cover. Solid tray shall be painted custom colour as specified by architect

.6 Basket style cable tray shall be electroplated welded wire-mesh, minimum of 50 x 100mm mesh size, 105mm deep, in standard 3048mm lengths. Tray width shall be 305mm or 450mm as noted on the drawings.

.7 Where required, provide framed cable or conduit drops.

.8 Provide cable clamps or ties at 1000 mm intervals to maintain alignment of cable in tray.

.9 All hanger rods and supports shall be galvanized.

.10 Solid cable tray shall be Legrand Cableofil FT Series or approved equal.

.11 Basket style cable tray shall be manufactured by Cooper B-Line Systems, Cablofil, Canstrut, Code Manufacturing Ltd., or Thomas and Betts 'Express' Tray.

2.2 WATERFALL KITS FOR DATA CABLES

.1 Provide data cable waterfall kits mounted to cable tray within Room 213 to support data cables and maintain cable radius as they transition from cable tray to data racks.

.2 Two (2) waterfall kits shall be provided for each data rack. Coordinate locations on site.

.3 Waterfall kits shall be steel or glass reinforced nylon construction, and be of the same manufacturer as cable tray

2.3 SUPPORTS

.1 Provide supports as required.

Part 3 Execution

3.1 INSTALLATION

.1 Install complete cabletrough system.

.2 The cable trays run within existing ceiling spaces shall be installed above ceilings where existing, to maximize headroom.

.3 Do not run tray within 300 mm of steam or hot water lines. Cable tray shall not be in contact of any sprinkler piping or laboratory gas lines.

.4 Cuts shall be filed smooth and treated with a galvanizing compound where cutting of certain sections is required.

□

.5 Cable tray shall be supported on 1500 mm centres, and shall be adequately braced to withstand loads due to pulling in of cables.

.6 Check routing and field dimensions to ensure there is absolutely no interference with work and equipment of other divisions. Cable tray routing may be altered to address existing ductwork and building elements upon approval by owner.

.7 Cable tray shall be bonded with manufactured grounding lugs every 15 meters with AWG #6 insulated copper unless otherwise noted.

.8 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.9 Install waterfall kits onto cable tray over data rack locations.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 CSAC22.2No.26, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

.3 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.4 National Electrical Manufacturers Association (NEMA).

.5 National Building Code 2010 (NBC 2010)

.6 National Fire Protection Association (NFPA)

.7 Institute of Electrical and Electronic Engineers (IEEE).

.8 Audio Engineering Society (AES).

.9 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

□

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 WIREWAYS

.1 Wireways and fittings: to CSA C22No.26.

.2 Sheet steel with hinged cover to give uninterrupted access.

.3 Finish: baked grey enamel.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

Part 3 Execution

3.1 INSTALLATION

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, connections to minimum.

.3 Install supports, elbows, tees, connectors, fittings.

.4 Install barriers where required.

.5 Install gutter to full length of equipment.

3.2 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information for incorporation into manual specified in:

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.2 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

3.3 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

□

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.
.2 Section 26 05 32 – Outlet Boxes, Conduit Boxes and Fitting
.3 Section 26 05 34 – Conduits, Conduit Fastenings & Conduit Fittings
.4 Section 50 00 – Lighting
.5 Section 26 27 26 – Wiring Devices

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.5 SYSTEM DESCRIPTION

.1 All supplied devices shall match the manufacturer of the previous phase 1 renovation project. Devices shall be manufactured by Leviton.

.2 Supply and install a fully programmable, networkable, and centralized low voltage lighting control system to provide automatic and manual control of the building’s interior and exterior

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lighting as shown on the drawings and as described herein. Components shall be networked where indicated on drawings.

.3 Groups of relays or channels, in multiple panels, shall be connected and automated using time of day, switching or dimming photocell control, and manual switch over-ride control. Lighting control panels shall be networked or interconnected by a data-line to operate as a stand-alone lighting control system.

.4 Each connected load shall be capable of being switched or dimmed as noted on the panel schematics. Loads shall be capable of being controlled independently or grouped into zones to provide multi-circuit control.

1.6 PERFORMANCE PARAMETERS

.1 The low voltage lighting control system shall be built with commercial off-the-shelf components such that any future requested changes or additions can be accommodated for without changing the existing system's components.

.2 All required control panels shall be capable of adding new panels daisy-chained to existing control panels without requiring the alteration of any other system hardware. System shall be capable of extending low voltage lighting control capabilities to future building renovations through the addition of these control panels.

.3 The low voltage light control system shall provide automatic control of connected interior and exterior lighting loads by timeclock, interior and exterior daylight sensors, and/or occupancy sensors as indicated on the drawings.

.4 Occupancy sensors shall automatically turn lights on upon the detection of movement. Where fixtures are controlled via a daylight sensor, light fixtures shall turn on to the pre-set levels determined by the daylight sensors. Lights shall automatically turn off when the room becomes vacant.

.5 Interior daylight sensors shall continuously adjust the light fixture output based on amount of natural light within the room or area. In specific rooms indicated on the drawings, fixtures shall be grouped and controlled in up to three daylight zones (Z1, Z2, Z3), with each zone dimmed independently to provide separate levels of dimming that are proportional to the amount of natural light available in that zone.

.6 Where fixtures are grouped and controlled in daylight zones, manual dimming over-ride switches shall adjust light levels of all fixtures within the group with each zone adjusted proportionally to the pre-set levels determined by the daylight sensor. Manual switches shall be capable of over-riding the daylight sensor to provide full brightness of fixtures.

.7 Manual low voltage switches shall provide over-ride capabilities to raise/lower, and/or switch (on/off) automatically controlled loads via remote relay panels or IRC's. When the lights within a room or area have been manually switched off, occupancy sensors shall automatically turn lights on upon the detection of movement after the sensor pre-set time delays.

.8 Exterior lighting zones shall be automatically switched based on time of day and exterior light levels as described on drawings. Timeclock scheduling shall be provided via the BMS. Exterior daylight sensor shall measure the actual exterior light level and automatically switch loads on or off.

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1.7 SHOP DRAWINGS

.2 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.1 Shop drawings shall include a fully detailed description of the system, control schematics, a single line of the entire system wiring diagrams for all system components, cable types, and operating instructions. Component equipment shall include relay or contactor control panel, transformers and power supplies, rectifiers, override switches, occupancy and photo-sensors, etc. Each component shall be identified as to the manufacturer, type, description and catalogue number.

.2 System riser shall be submitted with the shop drawings. Riser shall include all control boxes, cable, conduit, backbox, and rough in requirements for the system to ensure early coordination of supplier and contractor.

Part 2 Products

2.1 MATERIALS

.1 Provide all necessary components and devices for a complete and fully operational low voltage light control system. System components shall include, but not limited to, the following components:

.1 Low voltage digital switches

.2 Low voltage switching and dimming relays

.3 Power supplies

.4 Low voltage panels and/or individual room controllers

.5 Automated and manual switch controls

.6 Switching photocell controllers

.7 Continuous dimming photocell controllers

.2 All catalogue numbers shown are approximate and are intended to assist in providing the current features. Coordinate all catalogue numbers with the manufacturer to ensure a fully operable system. The catalogue numbers shown shall not reduce or amend the requirements of the specifications.

.3 All equipment and components shall be of the same manufacturer throughout.

.4 All materials provided shall be CUL listed and carry the CSA approval seal.

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2.2 RELAY PANELS

.1 Each new low voltage lighting control panel shall be a complete system with 4, 8, 12, 24, or 48-relay capacity, sized to suit capacity shown on the panel schematics. Each lighting control panel shall be sized with 20% spare relay capacity for future use. The lighting control panel shall include an intelligent card with built-in control logic, and photo-control package. The lighting control panels shall include the required networking modules and components to link multiple low voltage lighting control panels together for a flexible facility-wide lighting control system.

.2 The networked lighting control system shall provide a central location to maintain its programming data including schedules, programmable point overrides and parameter configuration. In the event of a component or panel failure, the system will continue to operate as programmed. The system shall have non-volatile memory to protect programming during power failures.

.3 Networking cable shall be FT6 plenum rated, Class 2, Cat6/5e cable, or as recommended by the manufacturer. Install cable within communications cable basket tray/conduit system unless noted otherwise. Cable colour shall be such that it is distinguishable from to the data/voice cable installed in the same tray system.

.4 The relay panels/IRC shall have integral photocell input capabilities. The photo-control input shall be connected directly to the panel to allow daylight harvesting switching and dimming capabilities. Dimming outputs (0-10V) shall provide up to three daylighting zones, each independently controlled proportionally to the photosensor input.

.5 Panels/IRC’s shall be capable of limiting the maximum output of each dimming zone to 60%.

.6 Relay panel tubs shall be surface mounted, type Nema 1 enclosures with conduit knock outs and removable hinged cover. Enclosures and components shall be suitable for installation in plenum spaces.

.7 Provide voltage barriers to separate line voltages fed from different sources into the same panel and to separate line voltages from class 2 low voltage wiring and the low voltage components of the system.

2.3 REMOTE CONTROL SWITCHES

.1 Local and remote switches shall be 2-button or 4-button low voltage digital switches, white with pilot light. Any button shall be configurable and upgradable to provide switching or dimming control of connected loads.

.2 Switches shall be connected and communicate with the light control system network. Switches shall draw power from the system network. No external power supplies shall be required.

.3 Provide stainless steel wall plates with the low voltage switches. Ganged wall plates shall be provided where the switches are grouped together at one location.

.4 All switch buttons shall be custom engraved. Engraving requirements shall be confirmed with shop drawings.

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2.4 PHOTOCELLS

.1 Indoor day-light sensors shall provide continuous dimming control (0-10V) of the designated lighting fixtures. The sensor shall control the light fixtures depending on the natural light available. The sensors shall be ceiling mounted and shall measure light reflected upward from the surface below. The sensor shall be easy to adjust with a range setting and a set-point at the device. The day-light sensor shall have an adjustable dead-band and 5-minute time delay setting so that cycling effects can be eliminated, adjustable setpoints 0 – 7500 lux, and adjustable time delay 3 seconds to 5 minutes, LED status indicator.

.2 Pendant mounted direct/indirect lighting sources may affect the operation of ceiling mounted photocells. The contractor shall adjust the sensors to allow for proper operation where such fixtures are provided.

.3 Low voltage photocells and sensors as located on the floor plans shall operate exterior lighting zones via the photo-controllers included with the low voltage lighting control system. The photo controller shall be capable of controlling any connected load in the panel network.

.4 Outdoor photosensors: Surface exterior wall mounted with weatherproof plate, range between 10 – 160 lux. All exterior fixtures shall be connected to photocell control.

2.5 OCCUPANCY SENSORS

.1 Provide where indicated and as described on lighting plans. The sensor shall be easy to adjust with a 5 minute time delay setting (adjustable from 30 seconds to 30 minutes), LED status indicator and push button programmable. Occupancy sensors shall be white in finish. Provide two (2) devices not shown on drawings of each type for Owner stockpile. See drawings for type of occupancy sensors required.

.1 OC1 – Extended range, dual technology, 360 degree sensor, ceiling mounted, low voltage.

.2 OC2 - Passive dual technology, 360 degree sensor, standard range, ceiling mounted, low voltage

2.6 LOW VOLTAGE RELAYS

.1 Provide switching and dimming (0-10V) relays to control zones indicated on plans.

.2 Relays shall be momentary-pulsed mechanically latching contactors with plug in connector. Relays shall have mechanically latching contacts with single moving part design.

.3 Contacts of low voltage relays shall be rated at 20 amp, 120 volt rated for electronic fluorescent ballasts, electronic LED drivers, resistive loads and up to ½ hp rated motor loads. Coils shall be mechanically held, momentary coil activation, operate on 24 volt, 60 Hz. Relays shall be equipped with pilot light switch operation. Provide for each relay, a varistor between line and neutral.

.4 Next to each relay mounted in the low voltage panel shall be an individual override button and a bi-colour LED to indicate status.

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.5 Dimming relay module shall be self-contained, 0-10V (sinking) in a single pole configuration. All dimming ballast/driver wiring connections shall connect directly to the relay module.

.6 All relays shall have a minimum short circuit current rating of 18,000 amps.

.7 Relay load terminals shall accept #14 to #6 AWG copper wire. Control wire terminals shall accept #14 to #12 AWG, copper.

2.7 POWER SUPPLY UNITS

.1 Power supplies shall be integral to the relay cabinets and sized to provide power output to operate all connected devices and components including of occupancy sensors, photosensors, digital switches, etc. External auxiliary power supplies shall be provided where the number of connected devices exceeds the onboard supply.

.2 Input voltage for the power supply shall be 120 volt AC. The power supplies shall include internal over-current protection, and voltage spike protection. Two pole power supply units may be provided where practical.

.3 Mount auxiliary power supply units adjacent to relay panels, where applicable. Locations of all power supply units shall be located on the as-built drawings.

2.8 BMS INTERFACE MODULE

.1 The low voltage lighting control system shall utilize the BMS interface module provided in phase 1 of renovations.

.2 The BMS interface module is used in lieu of the Network Clock to provide the same lighting control functions (with the exception of the Astronomic function), but shall allow an external automation device to provide the signal that changes channel status from Occupied to Unoccupied (after-hours).

2.9 OPERATOR'S SOFTWARE

.1 The operator's software program shall be compatible with Microsoft ® Windows 7, 8, and 10.

.2 The data-line shall be 18 AWG 4 unshielded copper conductors (two independent twisted pairs) meeting Class 2P NEC code requirements. The data-line may be run in a loop, serial or star configuration in accordance with the manufacturer's recommendations. Confirm all wiring and cable requirements with the manufacturer of the lighting control system. Maximum length for all data-line wire in the system is 457 meters (1,500 feet) without repeaters.

Part 3 Execution

3.1 INSTALLATION

.1 The low voltage lighting control panels shall be grouped and mounted adjacent to the electrical panels, as located on the floor plans.

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.2 All low voltage wiring shall be installed in conduit. Confirm with the manufacturer of this system all wiring and cable requirements.

.3 The system components shall be bonded to ground.

.4 Low voltage switches shall be as located on the floor plans, mounted up at 1200mm unless otherwise noted. Low voltage switches shall be ganged where more than one occurs in the same location. Labeling shall be applied to ganged switches to identify the areas in which the switches control.

.5 Data-line switches and/or photocells shall be mounted in the spaces as indicated on the lighting plans. Each low voltage wire shall be labeled clearly indicating which relay panel the cable is connected to.

.6 All relays and switches shall be tested after installation to confirm proper operation, and all connected loads shall be recorded on the relay schedule for each panel.

.7 Do not mount occupancy sensors within 1800mm of mechanical diffusers.

.8 Refer to manufacturer's literature for typical methods of installation and connection of components. The contractor shall be responsible for coordinating the actual components and equipment utilized so as to provide a fully operational and reliable system.

.9 Locate and install equipment in accordance with manufacturer's recommendations and as indicated.

.10 Provide separate junction box to allow for transition from 120 volt to low voltage wiring of power supplies.

3.2 CLOSEOUT SUBMITTALS

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

3.3 IDENTIFICATION AND DOCUMENTATION

.1 Provide lamecoid identification to the relay cabinets as named on the panel schematics. Individual relay load descriptions and the channels to which they are smart-wired shall be recorded on the relay schedule form provided with each relay panel.

.2 Where data-line switches are provided, each intelligent switch on a relay panel’s local data-line shall be numbered consecutively. The relays or channels controlled by each switch shall be recorded on the switch documentation form provided with the relay panel.

.3 Network Clock (or BMS Interface): The automation scenarios and operating data for each of the eight channels shall be recorded on the appropriate forms provided by the manufacturer.

.4 Include in the Electrical Operating Manuals, the system installation and operating manuals for the lighting control system, including the installation and operation of the Network Clock or BMS Interface Module. Include a copy of all forms and schedules provided for each relay panel.

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3.4 SYSTEM START-UP AND TRAINING

.1 Provide trained factory authorized technician to confirm proper installation, programming and operation of the system.

.2 Perform tests in accordance with Section 26 05 01 – Common Work Results – Electrical and Electrical Commissioning Specifications.

.3 Actuate control units in the presence of Engineer to demonstrate lighting circuits are controlled as designated.

.4 The Owner's operating and maintenance personnel shall be instructed in the operation and maintenance of the lighting control system by a trained factory authorized technician. The minimum training period shall be (4) four hours of instruction over two trips, with the second trip occurring two months after Owner occupancy. Written documentation bearing name and signature of Owner's personnel who received the above instruction shall be included in the operating Electrical Operating and Maintenance manuals.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.

.8 CSA-C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.9 CSA-C22.2 No.55, Special Use Switches.

.10 CSA-C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

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.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 SWITCHES

.1 15 A, 120 Volt and 347 Volt, single pole, three-way switches where required on drawings.

.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 molding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 White toggle.

.3 Toggle operated fully rated for tungsten filament, LED and fluorescent lamps.

.4 All wiring devices specified shall be of the same manufacture throughout the project.

.5 Switches controlling motors shall be K.W. (H.P.) rated and approved for motor control service.

.6 Set switches flush in all finished areas, or in surface box where conduit or wireway is exposed.

.7 Refer to drawing symbol schedule for further requirements.

.8 Switches and receptacles shall comply with requirements of CSA and NEMA Standards.

.9 Switches shall be specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

2.2 RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, with following features:

.1 White high impact chemical resistant molded nylon or polycarbonate face.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

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.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and rivetted grounding contacts.

.6 Specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

.2 Single locking receptacles CSA type L5-15 R, L6-30R, 125 V, 15 A, U ground with following features:

.1 High impact chemical resistant molded nylon or polycarbonate face.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.4 Specification grade from one of the following manufacturers: Cooper, Leviton, Hubbell or Pass & Seymour.

.3 All UPS powered receptacles specified above shall be blue

.4 All emergency powered receptacles specified above shall be red.

.5 Other receptacles with ampacity and voltage as indicated.

.6 Receptacles shall be of one manufacturer throughout project.

.7 Set receptacles flush in all finished areas, or in surface box where conduit or wireway is exposed.

2.3 COVER PLATES

.1 Cover plates for wiring devices.

.2 Cover plates shall be from one manufacturer throughout project.

.3 Wall plates shall be designed and manufactured in accordance with performance and dimensional requirements of the following industry standards:

CSA Standard C22-2 No. 42

U.S. Federal Specification WP455

NEMA Standard WD-1

.4 Wall plates shall be manufactured by one of the following:

Cooper, Arrow Hart, Eagle, Hubbell, Leviton or Pass & Seymour.

.5 Blank cover plates in finished ceiling areas shall be Columbia Electric #9002 baked white enamel for white ceilings, or painted to match colored finishes.

.6 Stainless steel wall plates shall be provided for all switches, receptacles, blanks, and special purpose outlets. The wall plates shall be of suitable configuration for the device for which it

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is to cover with color matched mounting screws. Use ganged plate where more than one device occur at one location. Refer to Section 27 05 28 for data and communications cover plate requirements.

.7 Where surface wiring methods need to be employed in a high finish area because of renovations to existing structure, wall plates shall be used in conjunction with Wiremold surface box to suit the device.

.8 Where outlets occur in an unfinished area such as boiler or furnace room and surface conduit and boxes are specified, stamped galvanized steel wall plates shall be used to suit configuration.

.9 All receptacles shall be provided with an engraved outlet box cover indicating circuit number.

.10 Exterior outlets shall be fitted with weatherproof “while in use” die cast aluminum cover plates to suit wiring device. Weatherproof covers shall provide protection in wet and damp locations.

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 Switches shall be as located on the drawings, mounted up 1200 mm, and ganged where more than one occurs in the same location.

.2 Receptacles:

.1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Convenience outlets shall be as located on the drawings, and mounted up 450 mm, unless otherwise noted.

.3 Where split receptacle has one portion switched, mount vertically and switch upper portion.

.4 Outlets over counter tops shall be mounted 150 mm above counter, or immediately above backsplash. Co-ordinate with architectural drawings for location of all counter tops, millwork and feature walls, to ensure proper location and mounting height.

.5 Coordinate with the location of all mechanical convectors and mount convenience outlets up 100 mm above heating convectors.

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.6 All convenience outlets shall meet tension tests as per CSA requirements, and will be subjected to 'on site' tests during final inspection.

.3 All plug-in type receptacles shall be identified by means of an engraved cover plate. Each cover plate shall contain the panel and circuit number. Those receptacles fed from ground fault interrupters shall have 'GFI' labeled adjacent to the panel and circuit number. Those receptacles designated for housekeeping purposes shall have ‘HOUSEKEEPING’ labeled adjacent to the panel and circuit number.

.4 The circuits controlled by all switches on all levels, shall be neatly printed with waterproof ink on the side of the switch outlet box so that the panel and circuit number are clearly legible when the cover plate is removed. It shall not be necessary to remove the switch from the outlet box in order to read the panel or circuit number.

.5 Cover plates:

.1 Protect cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer’s standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours’ notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

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.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Submit fuse performance data characteristics for each fuse type and size above 50 A. Performance data to include: average melting time-current characteristics.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

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1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.7 DELIVERY AND STORAGE

.1 Ship fuses in original containers.

.2 Do not ship fuses installed in switchboard.

.3 Provide a typed list of all spare fuses

.4 Provide three (3) spare fuses of each type and size installed.

Part 2 Products

2.1 FUSES GENERAL

.1 Fuses: product of one manufacturer for entire project.

.2 Fuse interrupting rating shall be 200,000 amperes RMS symmetrical, unless otherwise noted.

.3 Time delay fuses shall carry 500% of rated current for a minimum of 10 seconds and shall be labeled "Time Delay" by the manufacturer.

2.2 FUSE TYPES

.1 HRC fuses rated 600 amperes and smaller shall be CSA certified HRC1-J time delay and shall be in accordance with CSA Specification C22-2 No. 106-M92. HRC-1 fuse dimensions and current limiting performance shall be in accordance with the UL Standard 198C

Part 3 Execution

3.1 INSTALLATION

.1 Install fuses in mounting devices immediately before energizing circuit.

.2 Ensure correct fuses fitted to physically matched mounting devices.

.3 Ensure correct fuses fitted to assigned electrical circuit.

.4 Application of all fuses shall comply with the Canadian Electrical Code - Part 1 and local inspection authority regulations.

.5 Unless otherwise noted on the drawings, Time Delay fuses for overcurrent protection of motor circuits shall be rated at 150% of full-load current and

.6 Time Delay fuses for overcurrent protection of transformer circuits shall be rated at 125% of full-load current.

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.7 All fuses shall be manufactured by Littlefuse, Buss, Ferraz Shawmut**,** or Edison.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

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.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Include time-current characteristic curves for breakers with ampacity of 50 A and over or with interrupting capacity of 18,000 A symmetrical (rms) and over at system voltage.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

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.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

.1 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 deg C ambient.

.2 Common-trip breakers: with single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips.

.4 Circuit breakers with interchangeable trips as indicated.

.5 Circuit breakers to have minimum of 10,000 A symmetrical rms interrupting capacity rating in breaker panelboards.

.6 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.

.1 Trip settings on breakers to have adjustable trips.

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.

2.3 SOLID STATE TRIP BREAKERS

.1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous, tripping for ground fault short circuit protection.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers as indicated.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly

authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

END OF SECTION

□

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.2 American National Standards Institute (ANSI)

.1 ANSI C82.1, Electric Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.

.2 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

.3 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.4 ANSI/IEEE C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

.5 American Society for Testing and Materials (ASTM)

.6 ASTM F1137, Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.7 United States of America, Federal Communications Commission (FCC)

.8 FCC (CFR47) EM and RF Interference Suppression.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Shop drawings for each fixture shall include but not be limited to, lamps, ballasts, fixture cuts, custom colors, and special mounting details. All pertinent information for each fixture shall be stapled separately from other fixtures.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 10 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide detailed lighting calculation drawings for fixtures that are submitted for approval for offices, open office areas, or as requested by the consultant. These shall be submitted no later than 10 working days before tender close.

.4 The Bidder must provide a complete list of primary system products offered with their bid.

Part 2 Products

2.1 LAMPS

.1 Provide in wattages and types to properly suit the specified fixtures.

.2 T5 Linear Fluorescent Lamps:

.1 Miniature Bi-pin, slim 5/8" diameter for operating with high frequency electronic programmed start ballasts

.2 Colour Rendering Index (CRI) of 85

.3 Colour Temperature: 3500°K

.4 Nominal Life Rating: 20,000 hours

.3 Lamps shall be manufactured by Osram-Sylvania or Philips.

2.2 BALLASTS

.1 Ballasts for fluorescent fixtures shall be supplied with the fixtures, pre-wired for operation with the compatible lamps and quantity of lamps specified for the fixture. Provide ballasts in the voltage noted with the fixture specification.

.2 Fluorescent ballast systems shall include:

.1 Operate lamps for maximum efficacy, high lumen output operation and operate for full lamp life

.2 Eliminate lamp flicker

.3 UL Listed Class P, Type 1 Outdoor

.4 CSA Certified

.5 70°C Maximum Case Temperature

.6 FCC 47CFR Part 18 Non-Consumer for EMI and RFI filtering

.7 Class A Sound Rating

.8 ANSI C62.41 Category A Transient Protection

.9 CFCI Compatible

.3 Ballasts for Linear T5 Lamps

.1 Starting Method: Programmed Rapid Start

.2 Stepped Switching Ballast System where indicated bi-level 100% and 50% stepped output

.3 Ballast Factor (BF): 1.00

.4 Circuit Type: Series

.5 Lamp Frequency: >40kHz to reduce potential interference with infrared control systems

.6 Lamp Current Crest Factor (CCF): less than 1.6

.7 Total Harmonic Distortion: <10% THD

.8 Power Factor: >98%

.9 End of Lamp Life Sensing

.10 Manufacturer:

Sylvania 'Quicktronic PROStart T5 Professional Series
Advance 'Optanium Step Dim EL' series, available in 120-volt only

.4 Dimming Fluorescent Ballasts for T5, T5HO and Compact Fluorescent Lamps

.1 Starting Method: Programmed Rapid Start System

.2 Ballast Factor (BF): 1.00 – Normal Ballast Factor

.3 Circuit Type: Series

.4 Lamp Frequency: >40kHz to reduce potential interference with infrared control systems

.5 Lamp Current Crest Factor (CCF): less than 1.7

.6 Total Harmonic Distortion: <10% THD

.7 Power Factor: >98%

.8 Dimming Range: 100 to 10%

.9 1 – 10 Volt Control

.10 Anti-Flash Circuitry turns on in dimmed mode

.11 End of Lamp Life Sensing for T4 and T5 lamps

.12 Compatible with 4-pin compact fluorescent lamp types

.13 Manufacturers (unless noted otherwise):

Lutron 'Hi-Lume' series
Sylvania 'Quicktronic – Powersense' series
Advance Mark 10

.5 Fluorescent ballasts shall have inrush current limiting capability to assure compatibility with all lighting systems controls.

.6 Ballast Warranty: All fluorescent ballasts shall include a written manufacturer's warranty against defects in materials and workmanship for 60 months from date of substantial completion and include a nominal replacement labour allowance.

2.3 LED LIGHTING – LAMP MODULES AND DRIVERS

.1 Solid-State Lighting (LED luminaires) shall comply with ENERGY STAR® SSL test standards for the following qualification requirements:

.1 Testing: SSL testing standards including IES LM-79-2008 and LM-80-2008 as performed by an independent test lab.

.2 Efficacy: The luminaire test data and submitted report shall demonstrate a minimum of 35 lumens per watt and 575 lumens for the least efficient LED for apertures ≥ 4.5" (345 lumens for apertures ≤ 4.5"), lowest efficient optic, and hottest luminaire configuration for the product group submitted for qualification.

.3 Colour: LED luminaire shall demonstrate colour uniformity across the aperture.

.4 Power: The driver/power supply must have a power factor of > 0.90 for all non-residential products, meet FCC requirements, sound rating of A and provide transient protection.

.5 Reliability: The LED luminaire shall demonstrate 70% lumen maintenance at 35,000 hours for non-residential products, as calculated using the DOE's linear extrapolation model.

.2 Tight chromaticity specification and LED colour binning process shall ensure LED colour uniformity, sustainable Colour Rendering Index (CRI) and Correlated Colour Temperature (CCT) consistency over the useful life of the LED. Consistent colour uniformity and tight colour control shall be maintained even during dimming.

.3 LED modules shall be InGaN (Indium Gallium Nitride) semiconductor material, absent of UV and minimal IR wavelengths. The conglomeration of diodes covered with remote phosphor technology shall provide consistent colour uniformity and tight colour control.

.4 LED Light Engine (Driver)

.1 Over-voltage, over-current and short-circuit protected

.2 Thermal management of the LED system shall be designed to yield 70% lumen maintenance after 50,000 hours of operation

.3 Total Harmonic Distortion: < 20% THD

.5 LED fixtures where specified as dimmable, shall have a dimming range of 100% to 10% unless otherwise noted.

.6 Warranty: The light engine and power components of LED luminaires installed for indoor applications shall be free from defects in material and workmanship for a minimum period of three (3) years from date of original purchase. Warranty shall cover only product failure due to defective material or workmanship, and does not include labour to remove or install fixtures. Defective LED's shall be considered if a minimum of 5% of LEDs per luminaire are non-operative in the fixture or module.

2.4 LUMINAIRES

.1 Contractor is responsible for all required mounting details for all lighting fixtures. If mounting of fixture is uncertain, contractor shall confirm prior to finalising pricing.

.2 Lighting fixtures shall be of the makes indicated. Similar types of fixtures shall be by one manufacturer.

.3 Only clean luminaires and lamps will be accepted at time of final inspection.

.4 Recessed fixtures shall generally be supplied complete with trim, plaster frame or ring and mounting brackets where installed in plaster, or without plaster frame in acoustic ceilings.

.5 Fixtures shall bear appropriate CSA labels.

.6 Cooperate with all other trades for the proper installation of all lighting fixtures.

.7 Verify the quantity of fixtures before placing orders.

.8 Verify all ceiling types with architectural drawings and the General Contractor before ordering fixtures.

.9 Fluorescent lighting fixtures shall be so designed that the temperature on the ballast case shall not exceed a maximum of 70°C in an ambient temperature of 25°C.

.10 Co-ordinate with drawings to ensure that all fluorescent fixtures are equipped with ballasts of a suitable voltage to match branch circuitry.

.11 All fluorescent fixtures such as troffers, specified as being equipped with flat acrylic lens, shall be provided with lens not less than 3.175 mm thick, regardless of catalogue numbers specified.

.12 All fluorescent and LED troffers specified as being installed in inverted T-bar ceilings shall be painted on bottom face of fixture to match the T-bar splines unless otherwise noted.

.13 A self adhesive small circular label coloured blue shall be placed on a T-bar spline adjacent to each fixture housing the ballast to facilitate its location.

.14 All fluorescent luminaires installed on branch circuits with voltages exceeding 150 volts-to-ground shall be provided with a disconnecting means integral with the luminaire that simultaneously opens all circuit conductors between the branch circuit conductors and the conductors supplying the ballast(s), and shall be marked in a conspicuous and permanent manner adjacent to the disconnecting means so as to identify the disconnect.

.15 The new light fixture lamps shall not be used during construction. The contractor may use their own temporary lamps during construction at their own expense with the Owner's approval. The contractor shall replace temporary lamps with new lamps upon completion of work. All fixtures shall be cleaned inside and outside prior to substantial completion.

.16 Provide lighting fixtures of type and quality as specified in the following schedule. Fixtures shall be complete with necessary accessories, lamps and ballasts. The contractor shall advise of any restrictions on providing luminaire, lamp and ballast as specified during tender period.

.17 The lighting fixtures shall be as specified in the following schedule, and the manufacturer's numbers shown shall not reduce or amend the requirements as outlined under the description of each fixture type.

2.5 LUMINAIRE SCHEDULE

.1 Fixture type 'AA'

.1 Luminaire: Pendant linear LED direct fixture, 1219mm length, maximum 310mm width 347 volt drivers, die-cast extruded aluminum housing with end caps. Fixture shall be provided with a satin/smooth lens, 100% downlight reflector. Centre of fixture shall be mounted approximately 2,400mm A.F.F. by aircraft cable from structural joists. Confirm final mounting heights with architect and consultant prior to installation. Fixture finish shall be aluminum paint.

.2 Lamp: 48 watt, 800 lumens/ft LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable to 1%.

.4 Manufacturer:

Axis Lighting #Slim series
Alera Lighting #PLK series
Ledalite #Sync series
Or approved equal.

.2 Fixture type ‘AA8’

.1 Luminaire: Pendant linear LED direct fixture, 2440mm length, fixture shall be one continuous section with 2440mm length shielding, maximum 310mm width 347 volt drivers, die-cast extruded aluminum housing with end caps. Fixture shall be provided with a satin/smooth lens, 100% downlight reflector. Fixtures shall be suspended by aircraft cable from structural joists. Over workstations, centre of fixture shall be suspended approximately 460mm below suspended wood panels; in walkways centre of fixture shall be mounted approximately 2400mm A.F.F. Confirm final mounting heights with architect and consultant prior to installation. Fixture finish shall be aluminum paint.

.2 Lamp: 48 watt, 800 lumens/ft LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable to 1%.

.4 Manufacturer:

Axis Lighting #Slim series
Alera Lighting #PLK series
Ledalite #Sync series
Or approved equal.

.3 Fixture type ‘BB’

.1 Luminaire: Pendant linear LED direct fixture,1219mm length, 347 volt drivers, die-cast extruded aluminum housing with end caps and in-line joint components suitable for continuous row mounting as shown on plans. Fixture shall be provided with a interior reflector allowing 100% downlight, frosted acrylic lens. Fixture shall be mounted flush with bottom of architectural wooden slat bulkheads, roughly 2,700mm A.F.F. by aircraft cable from structural joists. Confirm final mounting heights with consultant. Fixture finish shall be aluminum paint.

.2 Lamp: 3.6 watts/ft, 400 lumens/ft LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable.

.4 Manufacturer:
Axis Lighting Beam 2 series
Focal Point Seem 2 Series
Or approved equal.

.4 Fixture type ‘CC’

.1 Luminaire: Recessed LED volumetric fixture suitable for installation in metal panel ceiling, 305 x 1219 mm, painted white steel frame and side reflectors, frosted acrylic center diffuser with satin lens. Fixture finish shall be aluminum paint.

.2 Lamp: 35 watt, 3000 lumen LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable to 1%.

.4 Manufacturer:

Focal Point Equation LED series
Axis Lighting Day LED series
Or approved equal.

.5 Fixture type ‘DD’

.1 Luminaire: Recessed LED volumetric fixture suitable for inverted t-bar ceiling or metal panel ceiling, 610 x 610 mm, painted white steel frame and side reflectors, frosted acrylic center diffuser with satin lens.

.2 Lamp: 34 watt, 3000 lumen LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable to 1%.

.4 Manufacturer:
Focal Point Equation series
Axis Lighting Day LED series
Or approved equal.

.6 Fixture type ‘EE’

.1 Luminaire: Suspended LED strip light, 1219mm length c/w frosted lens. Provide chain hanger to mount fixture to 2700mm A.F.F. unless otherwise noted. Coordinate final mounting height and locations with mechanical equipment and ductwork on site. Provide fixture complete with wire guard where specified on drawings with ‘WG’.

.2 Lamp: 40 watt, minimum 4000 lumen LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD.

.4 Manufacturer:
Cooper Metalux #SNLED series
Philips Day-Brite LF Fluxstream
Or approved equal.

.7 Fixture type ‘FF8’

.1 Luminaire: Suspended LED linear fixture, cylindrical profile, 89mm diameter, downlight distribution, diffuse frosted acrylic lens, extruded aluminum housing with powercoat painted top finish – architect to provide RAL colour code at shop drawing stage. Fixtures shall be continuously row mounted as indicated on drawings, maximum length 2440mm. Provide shorter sections in 1220mm increments to make up lengths required for layout shown. Fixtures shall be suspended with aircraft cable to a mounting height matching existing "tube lights" being removed. Connect fixtures into existing junction boxes and circuitry as the "tube lights" being removed. Coordinate final mounting height and locations with existing structure.

.2 LED: Medium output 40 watt, 826 Lumens/305mm, 3500K, minimum 80 CRI, 5-8 Watts/305mm length

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt input, < 20% THD. Integral transformer only - Remote mounted transformer will not be acceptable.

.4 Manufacturer:
A-Light ATM2 Series
Or approved equal.

.8 Fixture type 'GG'

.1 Luminaire: Recessed LED volumetric fixture suitable for installation in drywall ceiling, 305 x 1219 mm, painted white steel frame and side reflectors, frosted acrylic center diffuser with satin lens. Fixture finish shall be white

.2 Lamp: 35 watt, 3000 lumen LED module with remote phosphor technology, 3500K, minimum 80 CRI, 50,000 hours at 70% lumen maintenance,

.3 Driver: over-voltage, over-current and short-circuit protected, 347 volt, < 20% THD, dimmable to 1%.

.4 Manufacturer:
Focal Point Equation LED series
Axis Lighting Day LED series
Or approved equal.

.9 Fixture type 'C'

.1 Luminaire: Suspended LED pendant, 311mm diameter diffused acrylic refractor with linear pattern, extruded cylindrical aluminum top housing in black finish, clear flat bottom lens, 347 Volt input with 0-10 Volt dimming driver, 13 Watts. Suspend from ceiling with silver braided power cord with bottom of fixture mounted flush with bottom of decorative ceiling panels. Five year warranty.

.2 Lamps: minimum 1316 lumen LED module, 4,000K, 80 CRI, 50,000 hours at 70% lumen maintenance.

.3 **Driver: 347-volt input, 0-10 Volt dimming driver.**

.4 Manufacturers:

Luminis Prisma series
Or approved equal

.10 Fixture type ‘D’

.1 Luminaire: Suspended LED pendant, 406 mm diameter prismatic frosted UV stabilized acrylic refractor with linear pattern, extruded cylindrical aluminum top housing and decorative rods and ring around the reflector, color powder coat finish (amber), 347 Volt input, 179 Watts, 13,733 Lumens. Suspend from ceiling with mounting hub and 19mm stem painted to match fixture and cut to length. Bottom of fixture shall be level with underside of existing red painted steel beams to match existing height. Provide twist-lock male cord end to match existing receptacle. Five year warranty.

.2 Lamps: 13,733 lumen LED module, 3,500K, 80 CRI, 50000 hours at 70% lumen maintenance.

.3 **Driver: 347-volt input.**

.4 Manufacturers:
Stanpro HX9-L Series LED
Or approved equal.

.11 Fixture type ‘F’

.1 Luminaire: Surface mounted cylinder fixture, 140mm diameter, 257mm length, Suspended LED pendant, opal glass shade, stainless steel body. Fixture shall be ceiling mounted, connected into existing circuit and junction from existing vapour-proof fixtures being removed.

.2 Lamps: 980 Lumen, 3,000K, 8.4 Watts.

.3 **Driver: 120-volt input.**

.4 Manufacturers:
Bega 33 150 Series
Or approved equal.

.12 Fixture type ‘G’

.1 Luminaire: Surface wall mounted cylinder fixture, 140mm diameter, 257mm length, Suspended LED pendant, opal glass shade, stainless steel body. Fixture shall be wall mounted, connected into existing circuit and junction from existing vapour-proof fixtures being removed.

.2 Lamps: 980 Lumen, 3,000K, 8.4 Watts.

.3 **Driver: 120-volt input.**

.4 Manufacturers:
Bega 33 150 Series
Or approved equal.

.13 Fixture type 'H'

.1 Luminaire: Suspended LED pendant, 152 mm diameter faceted specular aluminum refractor, extruded cylindrical aluminum housing in powder coated black finish, clear flat tempered glass bottom lens, step down transformer to 347 Volt input with 0-10 Volt dimming driver, tilting mechanism allowing for 30 degree directional adjustability. Suspend from ceiling with suspension braided power cord with adjustable cable, bottom of fixture mounted flush with bottom of decorative ceiling panels. Five year warranty.

.2 Lamps: 18 watt, 1686 lumen LED module, 3500K, 80 CRI, 50000 hours at 70% lumen maintenance.

.3 **Driver: 347-volt input, 0-10 Volt dimming driver.**

.4 Manufacturers:

Luminis 'Syrios SY605 Series
Or approved equal.

.14 Fixture type 'L' recessed pot light.

.1 Luminaire: Recessed LED downlight suitable for mounting in inverted T-bar or drywall ceiling, 127mm diameter aperture, specular reflector with white trim, soft focus diffused lens.

.2 Lamps: 1200 lumen LED module, 3,500K, 80 CRI, 50000 hours at 70% lumen maintenance.

.3 Driver: over-voltage, over-current and short-circuit protected, 120-volt, <20% THD, dimmable.

.4 Manufacturers:
Cooper Lighting Halo # ML56 LED Series
Elite "B5 LED" Series
Prescolite "LC6LED' Series
Or approved equal.

.15 Fixture type 'N' surface mounted shower light suitable for wet locations.

.1 Luminaire: Surface LED round fixture suitable for drywall ceilings and gasketed for wet locations. 180-260mm diameter, 67-198 mm high, white housing with white powder coat finish, translucent white acylic or glass diffuser. Mount fixture on existing junction box and connect into existing circuitry from existing fixtures being removed. Provide gasket at ceiling to maintain wet rating.

.2 Lamps: 1100-1960 Lumens, LED module, 3,000K or 3,500K, 82 CRI, >50000 hours.

.3 120-volt, 12-22 Watts

.4 Manufacturers:
Bega 33680 Series
Magic Lite DL-6

Or approved equal.

.16 Fixture type 'PL1'

.1 Luminaire: Exterior pole with single mounted LED luminaire suitable for wet locations (IP66), extruded aluminum driver enclosure, die cast aluminum housing in powder coat grey finish, approximately 515mm wide x 800mm long, vandal resistant one-piece injection molded clear polycarbonate lens, standard arm mount. Type III cut-off lighting distribution pattern, 347 volt LED driver with 0-10V dimming, <20% total harmonic distortion, >0.9 power factor, start-up operation -40 degree C to 40 degree C, 90% lumen maintenance at 60,000 hours. 260 input Watts, 26,699 delivered lumens, 3000°K, c/w integral photocell control. Luminaire shall have five year warranty. Poles shall be round tapered, powder coated aluminum, 7620 mm (25 foot) high, and shall include anchor bolts, full base cover, hand hole, ground lug, top cap and all necessary accessories as required. Post top luminaire and lamp pole standard shall be grey finish. Refer to site plan drawings and details.

.2 Manufacturers:
Philips Gardco # PUREORM P32 series
Or approved equal

.17 Fixture type 'PL2'

.1 Luminaire: Exterior pole with two mounted LED luminaires each suitable for wet locations (IP66). Each luminaire shall be extruded aluminum driver enclosure, die cast aluminum housing in powder coat grey finish, approximately 515mm wide x 800mm long, vandal resistant one-piece injection molded clear polycarbonate lens, standard arm mount. Type III cut-off lighting distribution pattern, 347 volt LED driver with 0-10V dimming, <20% total harmonic distortion, >0.9 power factor, start-up operation -40 degree C to 40 degree C, 90% lumen maintenance at 60,000 hours. 260 input Watts, 26,699 delivered lumens, 3000°K, c/w integral photocell control. Luminaire shall have five year warranty. Poles shall be round tapered, powder coated aluminum, 7620 mm (25 foot) high, and shall include anchor bolts, full base cover, hand hole, ground lug, top cap and all necessary accessories as required. Post top luminaire and lamp pole standard shall be grey finish. Refer to site plan drawings and details.

.2 Manufacturers:
Philips Gardco # PUREFORM P32 series
Or approved equal.

.18 Fixture type 'PL3'

.1 Luminaire: Exterior pole with single mounted LED luminaire suitable for wet locations, extruded aluminum driver enclosure, die cast aluminum housing in powder coat grey finish, approximately 515mm wide x 425mm long, vandal resistant one-piece injection molded clear polycarbonate lens, standard arm mount. Type III cut-off lighting distribution pattern, 347 volt LED driver with 0-10V dimming, <20% total harmonic distortion, >0.9 power factor, start-up operation -40 degree C to 40

degree C, 90% lumen maintenance at 60,000 hours. 80 input Watts, 7660 delivered lumens, 3000°K, c/w integral photocell control. Luminaire shall have five year warranty. Poles shall be round tapered, powder coated aluminum, 6100 mm (20 foot) high, and shall include anchor bolts, full base cover, hand hole, ground lug, top cap and all necessary accessories as required. Post top luminaire and lamp pole standard shall be grey finish. Refer to site plan drawings and details.

.2 Manufacturers:
Philips Gardco # PUREFORM P21 series
Or approved equal

2.6 SPARE FIXTURES

.1 In addition to the quantities of fixtures noted on drawings, the contractor shall provide the following fixtures as spare, to be turned over to the owner upon completion of the project:

.1 Fixture type 'AA' – (1) additional fixture.

.2 Fixture type 'AA8' – (1) additional fixture.

.3 Fixture type 'BB' – (1) additional fixture.

.4 Fixture type 'CC' – (1) additional fixture.

.5 Fixture type 'DD' – (1) additional fixture.

.6 Fixture type 'EE' – (1) additional fixture.

.7 Fixture type 'L' – (1) additional fixture.

Part 3 Execution

3.1 INSTALLATION

.1 The contractor under this Division shall be responsible for expediting the delivery and installation of the fixtures to suite the construction schedule and the work of other trades.

.2 Remove packing material and debris from the job site immediately after installation of fixtures and lamps. Debris shall not be allowed to accumulate more than a reasonable amount.

.3 Industrial fixtures where suspended shall have 12 mm conduit hangers and ball aligners, the length and location shall clear equipment ducts and pipes.

.4 Lighting fixture diffusers are not to be installed until the area is completely finished in order to minimize the amount of dirt collection on these units.

.5 Exit signs shall be wired in a separate conduit system.

.6 Conduit installation shall conform to the specifications.

.7 Emergency battery lighting units shall be connected to the existing 120-Volt or 347-Volt lighting circuit, non-switched leg.

3.2 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 Operation instructions

.2 Description of system operation

.3 Description of each subsystem operation

.4 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.5 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

3.3 WIRING

.1 Each fixture shall be fed with a separate flex or AC-90 drop. Looping between fixtures or wiring rows through ballast channel will not be accepted.

3.4 LUMINAIRE SUPPORTS

.1 Lighting fixtures shall be supported independent of plasterboard or acoustic tile. Support from structural joist members of the building or ceiling.

.2 Where existing ductwork and other obstructions in the ceiling space are present, light fixtures shall be provided with a support system consisting of horizontal unistrut members spanning below the obstructions and supported by vertical threaded rods connected to the existing steel structure.

.3 Fixtures installed in exposed ceilings may require plywood backing behind the acoustical panels. Confirm support requirements with manufacturer.

.4 Where suspended fixtures are mounted directly below suspended architectural panels, cables supporting fixtures shall be routed through grommets within the architectural panels. Coordinated installation with architectural panel supplier/installer.

3.5 LUMINAIRE ALIGNMENT

.1 Luminaires shown in continuous lines or rows shall be carefully aligned so that all rows appear as straight lines.

.2 Fixtures shall be installed accurately in line and level. Any fixtures which are not installed properly shall be taken down and re-installed at no change to the contract sum. Plaster frames and rings required for recessed fixtures shall be supplied under this section, and installed under the lathing and plaster or acoustic ceiling divisions. The work of the electrical division

shall include the necessary co-ordination with the above divisions in regard to the correct location and installation of the plaster frame and rings.

3.6 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

3.7 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.8 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results – Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 CSA C22.2 No. 141, Unit Equipment for Emergency Lighting

.3 National Building Code 2010 (NBC 2010)

.4 National Fire Code 2010

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Shop drawings for each fixture shall include but not be limited to, lamps, ballasts, fixture cuts, custom colors, and special mounting details. All pertinent information for each fixture shall be stapled separately from other fixtures.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance information

.1 Section 01 78 00 - Closeout Submittals

.2 Include:

.1 Operation instructions

.2 Description of system operation

.3 Description of each subsystem operation

.4 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.5 Parts list specifying parts used in equipment by identification numbers that are standard to electronic industry.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 – Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan. \

1.7 WARRANTY

.1 The warranty period for the supply and installation of emergency battery units and remote emergency lighting fixtures shall commence on the date of substantial completion regardless of the manufacturer's specific warranty disclaimers with respect to date of shipment or date of installation of the equipment. The warranty period from date of substantial completion is one full year.

.2 Provide a full replacement warranty of the emergency lighting equipment free of defects in material and workmanship for a period of (1) one year from date of substantial completion. In addition to this requirement:

.1 Batteries shall include a pro-rated warranty for a minimum (5) five years shall commence the date the full warranty period ends.

.2 Integral and remote MR16 LED lamps shall have a (5) year warranty from date of substantial completion.

.3 A battery determined to be defective during the pro-rated warranty period shall be repaired or replaced at a cost equal to the net price in effect at the time, reduced by the percentage obtained in multiplying 10% by the number of full years remaining in the total warranty period. Such repair or replacement at this adjusted price shall be the purchaser's exclusive remedy.

Part 2 Products

2.1 EQUIPMENT

.1 Emergency lighting equipment: to CSA C22.2 No. 141.

.2 Products shall be compatible with the Nexus RF emergency lighting monitoring system.

.3 Emergency lighting units shall be battery contained units 120 volt and 347 volt, with a combination of remote heads interconnected as indicated on drawings, including wiring to a DC terminal block in the exit sign fixtures.

.4 Output voltage: 12 V, DC.

.5 Battery: sealed long-life, maintenance free lead acid battery with 10-year life expectancy.

.6 Charger: solid state, pulse type charger, current limited, temperature-compensated, short-circuit proof, reverse-polarity protected. Unit standard with electronic lockout and brownout circuits. Complete battery recharge in 24 hours.

.7 Solid state transfer circuit.

.8 Low voltage battery circuit protection to disconnect the battery form the fused output circuit at the end of discharge.

.9 Non-audible LED diagnostic display to identify source of failure: battery, charger circuitry or lamps.

.10 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.11 Lamp heads: Integral to battery unit unless otherwise noted, 345° horizontal and 180° vertical adjustment without need for tools to adjust aim. Lamp type: 6 watt 12-volt MR16 LED.

.12 All emergency lighting fixtures shall be surface mounted up 2100mm unless otherwise noted. Lighting heads shall be adjusted on site to provide optimum lighting within the area with an emphasis directed at illuminating means of egress towards the exits. Coordinate mounting heights with architectural elevation drawings prior to rough-in.

.13 Battery units shall be labeled with identification numbers to match the owner's existing numbering system. Contractor shall coordinate with the owner.

.14 Emergency lighting units and remote fixtures shall be as specified in the following schedule, and the manufacturer's numbers shown shall not reduce or amend the requirements as outlined under the description of each fixture type.

Fixture type 'E-MA': Emergency lighting unit shall be a battery contained unit with two integral lighting heads equipped with 2 x 6 watt, **12-volt** MR16 LED lamps. The emergency battery unit shall have a minimum **108 watt** capacity for 30 minutes, sealed long life battery with 10 year life expectancy. Solid state charger and battery protection circuit. Include auto-test self-diagnostic option, 120 and 347 Volt input. Unit shall be Nexus RF compatible.
Emergi-Lite - #NXM Series
Ready-Lite - #TUF-NM Series

Fixture type 'E-R2' – Emergency remote light fixture powered from fixture type 'E-MA', 'as indicated, 2 x 20 watt **12 volt** MR16 lamps, fully gasketed cast aluminium back plate in white finish, clear polycarbonate cover. Subscript shall designates battery in remote which remote is connected to.
Emergi-Lite – Survive-All NXM series
Ready-Lite - #TUF-NM Series

Emergency Lighting Monitoring System 'NEXUS RF Series' – Wireless radio frequency (RF) communication system capable of activating and testing individual or multiple emergency lights and generating reports. System is 900 MHz mesh networking technology with optimum channel selection, graphical user interface (GUI) accessible on wireless area controller (AC) also stores the master database, operates as a user interface c/w keypad and LCD touch screen, coordinates nodes both through the routers and its own cluster. The area controller router (ACR) can coordinate a cluster of up to 90 nodes and maintains the database independent to the (AC). Unit c/w touch screen, USB ports, Ethernet connection, battery back-up, SD slot for removable memory, CF slot for memory or peripheral devices. Unit is capable of logging test results and generating reports using NEXUS reporting functions. Provide all components and wiring and cables and interface modules for a fully operational system.

RF Area Controller (AC) – head end database system, coordinates up to 90 nodes, 128MB RAM, SD flash memory 2GB, 100-240VAC 50/60Hz, 12VDC @2.1A output, 918 to 925.8 MHz, battery backed, integrated web server, 2 meter Blue Cat5e UTP patch cord, wall bracket c/w security latch, USB ports for connection to keyboard, mouse, printer and PC, 1GB USB flash memory stick, Ethernet port, 50 ohm SMA antenna jack and 75mm stub antenna.

Nexus RF Repeater (REP-EL) – Provide five (5) RF repeaters to boost the RF signal where required. Provide 120 Volt connection from the nearest existing 120 Volt non-switched circuit. Locations are not shown on drawings - Coordinate locations on site with manufacturer during system setup where stronger RF signal is required.

2.2 ADDITIONAL MATERIALS

.1 In addition to the materials specified and the quantity of materials as determined on the plans, provide for the supply and installation of the following additional materials, which shall be turned over to the owner if not installed during construction:

Fixture type 'E-R2': 3 fixtures

.2 For each spare emergency light fixture listed, include in the base pricing the supply and installation of 2 # 10 RW90 and insulated ground in 10 meter length of 16mm conduit (including fittings).

Part 3 Execution

3.1 INSTALLATION

.1 The contractor under this Division shall be responsible for expediting the delivery and installation of the fixtures to suite the construction schedule and the work of other trades.

.2 Batteries for lighting units if placed in storage prior to installation shall be placed in an environment protected from cold and extreme heat. Store batteries in accordance with the manufacturer's recommendations. Batteries shall have a maximum storage life (shelf life) of 6 months. Batteries must be recharged or placed in service within the 6 months of storage life.

.3 Remove packing material and debris from the job site immediately after installation of fixtures and lamps. Debris shall not be allowed to accumulate more than a reasonable amount.

.4 Lighting fixtures installed in any area that is not completely finished shall be cleaned at the end of the construction.

.5 Emergency battery lighting units shall be direct connected to the room's light circuit (non-switched leg).

.6 Battery units shall be labeled with identification numbers to match the owner's existing numbering system. Contractor shall coordinate with the owner.

.7 Mounting heights: The minimum mounting height of emergency lighting battery units and remote emergency light fixtures shall be as noted herein, unless otherwise noted on drawings:

.1 Emergency battery units: 2100mm above finished floor.

.2 Emergency remote fixtures: Ceiling mounted or wall mounted as indicated on the floor plans. Wall mounted fixtures shall be a minimum 2100mm above finished.

.8 Lighting heads shall be adjusted on site to provide optimum lighting within the area with an emphasis directed at illuminating means of egress towards the exits.

3.2 WIRING

.1 Conduit: in accordance with Section 26 05 34 – Conduits, Conduit Fastenings and Conduit Fittings.

.2 Conductors: In accordance with Section 26 05 21 – Wires and Cables 0 – 1000 V

.1 In accordance with Section 26 05 21 – Wires and Cables 0 – 1000 V

.2 Minimum #12 AWG Copper up to maximum 5% voltage drop.

.3 Each fixture shall be fed with a separate flex or AC-90 drop.

.4 Providing wiring from the battery unit emergency dc circuit to the exit sign DC terminal block.

3.3 LUMINAIRE SUPPORTS

.1 Lighting fixtures shall be supported independent of plasterboard or acoustic tile. Support from structural members of the building or ceiling.

.2 Fixtures installed in exposed ceilings may require plywood backing behind the acoustical panels. Confirm support requirements with manufacturer.

3.4 LUMINAIRE ALIGNMENT

.1 Fixtures shall be installed accurately in line and level. Any fixtures which are not installed properly shall be taken down and re-installed at no change to the contract sum.

3.5 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.6 DEMOLITION

.1 Remove all existing emergency lighting battery and remote units in the building c/w conduit and wiring.

3.7 TRAINING

.1 Perform training in accordance with section 26 05 01 - Common Works Results – Electrical.

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

.2 National Fire Protection Association (NFPA) requirements

1.2 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittals .

.2 Submit product data sheets for exit lights. Include product characteristics, performance criteria, physical size, limitations and finish.

.3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

Part 2 Products

2.1 STANDARD UNITS

.1 Exit signs: to CSA C22.2 No.141 and CSA C860, packaged in accordance with the Canadian Code for Preferred Packaging guidelines.

.2 Exit sign fixtures shall be LED (Lighting Emitting Diodes), solid state design with high output LED's for a maximum 2 watts per sign single or double face.

.3 Exit sign fixture shall be compatible with the Nexus RF emergency lighting monitoring system and shall be c/w Nexus wireless system interface.

.4 Universal input voltage of 120, 277 or 347 Volt AC.

.5 DC terminal block for 12 Volt DC input

.6 Aluminum housing in white finish

.7 Acrylic barrier

.8 Three green "Running Man" pictograms for direction selection (straight, left and right)

.9 Universal mounting

.10 Minimum five year warranty.

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.11 Exit signs shall be one of the following manufacturers:

Ready-Lite 'RA' Series, Emergi-Lite #EA series,

2.2 Fixture Type 'X1'

Exit sign, ceiling mounted, single face, direction indicators as shown on drawings.

2.3 Fixture Type 'X2'

Exit sign, ceiling mounted, double face, direction indicators as shown on drawings.

2.4 Fixture Type 'X3'

Exit sign, surface wall mounted, single face, bottom of fixture mounted 100mm above door, direction indicators as shown on drawings.

2.5 ADDITIONAL MATERIALS

.1 In addition to the materials specified and the quantity of materials as determined on the plans, supply and install the following additional exit sign fixtures:

Fixture type 'X1': 2 x additional exit fixtures
Fixture type 'X2': 2 x additional exit fixtures
Fixture type 'X3': 2 x additional exit fixtures

.2 For each additional exit sign fixture noted, include supply and installation conduit/wire for connection of the additional exit fixtures:

.1 120V / 347V : 10 meters of 2 # 12 RW90 plus insulated ground wire in 10 meters of 16mm conduit per fixture

.2 DC Input: 10 meters of 2 # 10 RW90 in 10 meters of 16mm conduit per fixture

.3 Location of the additional exit sign fixtures to be confirmed on site with the Consultant.

Part 3 Execution

3.1 INSTALLATION

.1 The contractor under this Division shall be responsible for expediting the delivery and installation of the exit fixtures to suit the construction schedule and work of other trades.

.2 Install exit signs so as to be visible from the exit approach.

.3 Exit signs shall be wired in a separate conduit system.

.4 Interconnect exit fixtures to the emergency lighting battery unit emergency circuit.

.5 Ensure the exit sign circuit breaker is locked in the 'ON' position.

.6 Exit sign shall be connected into the Nexus RF emergency lighting monitoring system specified in Section 265200.

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3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

3.3 VERIFICATION

.1 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.2 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.4 DEMOLITION

.1 Remove all existing exit signs in the building c/w wiring and conduit.

3.5 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.2 Canadian Standards Association, (CSA International)

.1 CSA-T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568A with modifications).

.2 CSA-C22.2 No. 214, Communications Cables (Bi-national Standard, with UL 444).

.3 CAN/CSA-C22.2 No. 182.4, Plugs, Receptacles, and Connectors for Communication Systems.

.3 Telecommunications Industry Association (TIA)

.1 TIA/EIA/ANSI – 568B.1/2/3 latest revision Commercial Building Standards for Telecommunications Pathways and Spaces;

.2 TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises;

.3 TIA-568-C Series Commercial Building Telecommunications Cabling Standard;

.4 TIA/EIA-569 Commercial Building Standard for Telecommunications Pathway and Spaces;

.5 TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Building;

.6 TIA/EIA-607 Commercial Building Ground (Earthing) and Bonding Requirements for Telecommunications;

.7 Category 6A system and testing as released by TIA/EIA/ANSI – latest revision

.8 TIA/EIA T568-A UTP wiring/pinout

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1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 SYSTEM DESCRIPTION

.1 The data and voice cable installation shall include all cable, patch panels, patch cords, connectors, terminations, and coverplates. New data cables shall be terminated on new patch panels within existing racks within existing Room 003 in the basement. New voice cables shall be terminated at the existing SaskTel voice bix blocks within existing Room 003 in the basement. Provide cable cross-connects to SaskTel incoming cables.

.2 The cabling system shall meet or exceed the minimum characteristics as outlined TIA Standards Category 6A. In addition, the testing method and parameters shall be as per the TIA recommendations.

.3 The cabling installer shall be a Belden Certified System Vender installing Belden components. Once completed, the installation must be a Belden Certified System. The data system and components shall be guaranteed for a period of twenty (20) years from the date of installation against defects in materials and workmanship.

1.6 SUBMITTALS

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures and 26 05 01 – Common Work Results, Electrical.

.2 Submit shop drawings for review prior to ordering equipment. Shop drawings shall include but not be limited to, photocopies of accredited installers, cabling, hardware and components, patch cords, tester information, and labeling.

.3 Submit manufacturer's certification documentation that guarantees installation techniques, cable and cabling components and carry a minimum 20 year certification from the manufacturer for the capability to support gigabit applications such as 1000 Base-T, 622MB/s and 2.4 Gb/s ATM and work case channel performance based on the values indicated. The term channel performance incorporates manufacturer certified patch cords.

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.4 Upon request and at no cost, the contractor shall provide a manufacturer's technical representative to conduct an onsite visit to ensure complete technical compliance.

.5 The manufacturer's certification must guarantee that design or installation negligence on the part of the certified contractor will not negate or void any portion of the certified system. The manufacturer must guarantee that all material, components and labour are covered for the full certification period. It must also guarantee that in the event a contractor is no longer in business, the full certification remains valid.

1.7 CONTRACTOR QUALIFICATIONS

.1 The Installer (Firm and Employees) conducting the installation shall have full working knowledge of cabling low voltage applications such as, but not limited to data/voice communications cabling systems. The Installer shall have at least five years of continuous recent experience on similar projects. The Installer shall hold recent, up-to-date licenses, certifications and training certificates in the area the project is located and for the equipment to be installed. The Installer shall:

.1 Provide references of the type of installation provided for this specification;

.2 Be a Belden Certified System Vendor.

.3 Have a knowledge of all applicable Telecommunication standards such as but not limited to CSA, TIA/EIA, IEEEE and ANSI;

.4 Have a experience in the installation of pathways and support for horizontal and backbone cabling;

.5 Be experienced in the installation and testing of telecommunication network cabling system, including the use of light meter and OTDR.

.6 Provide proof of being a manufacturer certified installer for all cable network components being installed such as but not limited to cables, connectors and end termination equipment. The use of non-manufacture certified installer is not permitted.

1.8 PROJECT CLOSEOUT

.1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures and 26 05 01 – Common Work Results, Electrical.

.2 Operating and Maintenance Manuals at project closeout shall include

.1 List of cables, hardware and components;

.2 Copies of approved shop drawings;

.3 Record drawings.

.4 Warranty certification from the Manufacturer

.5 Receipts that include the listing of spare parts, materials and supplies, including patch cables and equipment cords.

.6 Test and verification reports (may be submitted on CD Disk inserted in an appropriate envelope page in the manual).

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Part 2 Products

2.1 COMMUNICATION CABLES, PATHWAYS AND TERMINATION BLOCKS

.1 Refer to Section 27 05 14 - Communication Cables Inside Buildings

.2 Refer to Section 27 05 28 – Pathways for Communications Systems

.3 Refer to Section 27 11 19 – Communications Termination Blocks

Part 3 Execution

3.1 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 The communications cabling system and testing shall comply with the following standards. All standards shall be as per the latest revision at the time of tendering this project.

.1 TIA/EIA/ANSI – 568B.1/2/3 latest revision
.2 Category 6A system and testing as released by TIA/EIA/ANSI – latest revision
.3 TIA/EIA T568-A UTP wiring/pinout
.4 BICSI, TDMM Telecommunications Distribution Methods Manual (latest edition)
.5 CAN/CSA-T529-M91
.6 CAN/CSA-T530-M90
.7 CAN/CSA-T527-94, EIA/TIA-607
.8 CAN/CSA-T528-93, EIA/TIA-606
.9 EIA/TIA-TSB 40-A
.10 EIA/TIA-TSB 67
.11 EIA/TIA-569
.12 EIA/TIA-606

.3 The total installation shall be completed by the cable Installer who is certified by the manufacturer for Category 6A cable installations. The Installer shall submit photocopies of accreditation certificates with the shop drawings. Submit testing method and tester with shop drawings.

.4 The contractor shall submit the verified test result on each cable, connector, and connection for the total installation, including back-bone and horizontal cabling. The model number and manufacturer of the Category 6A cable shall be documented. The type of tester used for testing the Category 6A cabling must also be documented.

.5 Test results shall be evaluated by the test equipment using the most up-to-date criteria from the TIA/EIA Standard. This information shall be supplied in electronic format.

.1 Room number of installation

.2 Wall plate ID

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.3 Test Results with an identification of type of test used and whether the result was PASS or FAIL

.6 Category 6A cable tests shall provide results for the following tests:

.1 Near End Crosstalk (NEXT)

.2 Attenuation

.3 Ambient Noise

.4 Attenuation to Crosstalk Ration (ACR)

.5 Far End Crosstalk (FEXT)

.7 Provide with maintenance manuals, a marked set of prints illustrating the network drop name for each drop location. No other as-built information shall be provided on these prints unless it relates to the data or voice network.

.8 The consultant will spot test this testing following test completion. Contractor shall provide the testing technician for (2) hours, and the completed test charts, for spot check verifications.

3.2 WARRANTY

.1 Testing and certification of the building network distribution cable installation shall be by the Installer and shall include the provision of a full Manufacturer's and Vendor's Warranty covering performance, products and installation. The Warranties shall cover the full repair and/or replacement of any component failing or failure to meet the design requirements within one (1) year. Warranties shall be delivered to the Project Manager with the Testing and Certification documentation.

.2 Within ten (10) days after testing, the Installer shall submit the cable test results, and a marked up record drawing(s) of the as-built cable network. The record drawing(s) shall include the cable/jack identification at the outlet locations.

.3 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.4 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts

3.3 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the

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following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.4 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.
.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).
.3 National Electrical Manufacturers Association (NEMA).
.4 National Building Code 2010 (NBC 2010)
.5 National Fire Protection Association (NFPA)
.6 Institute of Electrical and Electronic Engineers (IEEE).
.7 Audio Engineering Society (AES).
.8 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures
.2 Section 26 05 01 – Common Work Results

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

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.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.6 SYSTEM DESCRIPTION

.1 The data and voice cable installation shall include all cable, connectors as specified and shown on drawings.

.2 The cabling system shall meet or exceed the minimum characteristics as outlined TIA Standards Category 6A. In addition, the testing method and parameters shall be as per the TIA recommendations and meet requirements for testing Category 6A installations.

.3 The cabling system shall use matched components from a single manufacturer certified to deliver system performance over the lifetime of the applications which the cabling system was originally designed to support. The data system and components to be certified by the manufacturer and shall be guaranteed for a period of twenty (20) years from the date of installation against defects in materials and workmanship. The manufacturer shall be Belden.

.4 Each cable shall be equipped with connectors on each end and connected to wall jacks or cable connectors. All field communications cabling to be terminated on patch panels located on the drawings.

.5 The data cabling channel shall not exceed four (4) connections and shall not exceed 90m.

Part 2 Products

2.1 HORIZONTAL COMMUNICATIONS BUILDING CABLE (CBC)

.1 All communication cable (data and voice) shall be unshielded twisted pair, Category 6A. four (4) pair #23 AWG, CMP (FT6) rated and meet TIA/EIA/ANSI – 568-C.2, latest revision unless noted otherwise. Data cable colour shall be blue unless noted otherwise on drawings.

.2 Each cable shall be equipped with connectors on each end at the wall jacks and patch panels at the data equipment racks.

.3 The data cabling channel shall not exceed four (4) connections and overall length shall not exceed 90m. The maximum distance shall include an allowance of 3 meters from the outlet to the workstation and 6 meters for patch cords.

.4 Data and voice may be installed in a common box.

2.2 NETWORK PATCH CORDS

.1 Pre-terminated, factory tested patch cords shall be of the same manufacturer as the installed system and shall be part of the certified system. Patch cords shall be labeled at both ends.

.2 Patch cords for data and voice cables shall have stranded conductors and meets the requirements of TIA/EIA 568A (latest revision). Patch cords shall meet Category 6A criteria when tested with the components of the system. Patch cords at workstations shall be Category 6A cable terminated with 8 pin modular male jacks, TIA T568A pinout.

.3 Provide two (2) patch cords for each cable drop located on the plans.

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.4 Provide cords in the following lengths: 50% (data total) shall be 3.05m length; 30% (data total) shall be 4.2m length; 20% (data total) shall be 2.1m length.

.5 Patch cords shall be provided in the following colours for each length noted above, but shall be confirmed with the owner prior to turn over:

.1 20% - Green (Internet)

.2 80% - Blue (ROSS)

.6 At each voice jack location at the workstation, provide a manufactured Ethernet RJ45 Male to RJ11 Female adapter converter. The RJ45 male adapter shall be separated from the RJ11 female adapter with a minimum 150mm cable to allow adjacent patch cables to be installed in the wall plate.

Part 3 Execution

3.1 INSTALLATION OF COMMUNICATION CABLES

.1 All cable shall be pulled using proper wire grips. Pulling force and bend radius shall not exceed manufacturer's specifications.

.2 Velcro straps shall be used in all locations, cable ties are unacceptable.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

.4 During the warranty period, provide three (3) separate site visits of four (4) hours each on site for owner revisions and additional training.

3.3 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon

completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.4 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 National Fire Protection Association (NFPA)

.6 Institute of Electrical and Electronic Engineers (IEEE).

.7 Audio Engineering Society (AES).

.8 Other Applicable CSA and UL approvals.

.2 Telecommunications Industry Association (TIA)

.1 TIA/EIA/ANSI – 568B.1/2/3 latest revision Commercial Building Telecommunications Cabling Standards for Telecommunications Pathways and Spaces;

.2 TIA/EIA/ANSI – 515000 Generic Specification for Optical Fibre and Cable Splices

.3 TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises;

.4 TIA-568-C Series Commercial Building Telecommunications Cabling Standard;

.5 TIA/EIA-569 Commercial Building Standard for Telecommunications Pathway and Spaces;

.6 TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Building;

.7 TIA/EIA-607-A Commercial Building Ground (Earthing) and Bonding Requirements for Telecommunications;

.8 Category 6A system and testing as released by TIA/EIA/ANSI – latest revision

.9 TIA/EIA T568-A UTP wiring/pinout

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Submit shop drawings for review prior to ordering equipment. Shop drawings shall include but not be limited to, photocopies of accredited installers, outlets, and coverplates.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.6 SYSTEM DESCRIPTION

.1 Telecommunications raceways system consists of outlet boxes, cover plates, cabinets, racks, conduits, cable troughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

Part 2 Products

2.1 MATERIAL

.1 Conduits: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings

.2 Cable troughs: type, in accordance with Section 26 05 36 - Cable Trays for Electrical Systems

.3 Junction boxes, in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets

2.2 OUTLET BOXES

.1 Outlet boxes shall be 100mm square boxes. Multiple boxes shall not be ganged unless noted otherwise.

.2 Wall plates for communication cable systems shall be white and have integral self labeling. The wall plates must support up to four (4) network drops and be run in a minimum of **27mm**

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conduit to the nearest equipment rack or stub at the basket tray in the accessible ceiling. Provide blank filler plates for unused drops.

.3 Wall plates shall be modular and in 'Keystone' format opening to allow the possibility of changing connector types in the future without replacing the wall plate. Faceplates shall be equipped with small form factor terminating connectors to fit the individual outlet's requirements (RJ45 and or Dual LC and or CATV bulkheads).

.4 Wall plates shall be equipped with a minimum of four (4) angled keystone openings. The installer shall equip the wall plate with the required amount of blank inserts as required. The minimum standard of acceptance for wallplates are Corning WLL-PL-AP or Panduit NK4VSFWH.

2.3 CABLE MANAGEMENT

.1 Velcro ties shall be used. Each cable type shall be bundled separately; that is data bundle, voice bundle, and fibre bundle. Cable ties wraps are unacceptable. Ensure maximum distance between cable Velcro wraps is 610mm.

Part 3 Execution

3.1 SECURITY

.1 All cabling shall be installed in conduit in areas deemed unsecured. Unsecured areas, unless otherwise noted include the following:

.1 Any area accessible by more than one tenant or the public.

.2 Any area where cabling crosses from one tenant space to another tenant space.

.2 No communication (data, voice or fibre) cabling shall share same raceway or junction boxes with any other pathway system.

3.2 INSTALLATION

.1 All horizontal cables shall be run in conduit or cable tray. All raceways shall be grounded. All conduits shall have suitable bushings.

.2 Backbone/riser cables and horizontal cables shall be run in EMT conduit, minimum 27mm diameter unless otherwise noted on drawings. Use existing 53mm area conduits in the ceiling space and provide new as shown and required. Maximum allowable percentage conduit fill shall not exceed 40%.

.3 EMT conduit shall be reamed and bushed at both ends and bonded to the distribution system. Rigid PVC or flexible metallic or PVC conduits are not acceptable.

.4 Inside radius bend in EMT conduit shall not be less than 6 times the internal diameter for conduit sizes up to 41mm inside diameter; 10 times the internal diameter for conduit sizes 53mm diameter and larger.

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.5 Pull boxes shall be installed in conduit runs where the total number bends exceed 180 degrees; where the overall length of the conduit run is more than 30m, or if there is a reverse bend in the run.

.6 Pull boxes shall be installed in the straight sections of the conduit run and shall not be used lieu of a bend. Corresponding ends of conduit shall be aligned with each other. Conduit fittings shall not be used in place of pull boxes or bends.

.7 Use of LL, LR and LL conduit fittings is not permitted.

.8 The use of J-Hooks, brackets, cable ties and other attachments to support cabling **is not** permitted. Meshed-basket Data Cable tray is required. J-Hooks shall be permitted to support cable only where cables leaves cable tray and feeds outlets, and shall be provided every 1500mm.

.9 Cables shall be supported as close as possible to the underside of the structure above.

.10 In all wall outlet boxes, the contractor shall leave 400mm length of cable in each box.

.11 In all wall workstation drops, leave 300mm of cable slack before entering wall or workstation in suspended ceiling.

3.3 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

.4 During the warranty period, provide three (3) separate site visits of four (4) hours each on site for owner revisions and additional training.

3.4 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

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.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.5 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 The General Conditions of Contract, Division 01 General Requirements and all Addenda thereto form an integral part of and must be read in conjunction with the requirements of this Section.

.2 Cooperate and coordinate with the requirements of other units of work specified in other Sections.

1.2 REFERENCES

.1 The Electrical Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the 2012 Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 CSA C22.1-2012, Canadian Electrical Code, Part 1.

.2 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.3 National Electrical Manufacturers Association (NEMA).

.4 National Building Code 2010 (NBC 2010)

.5 Institute of Electrical and Electronic Engineers (IEEE).

.2 Canadian Standards Association (CSA) International

.1 CAN/CSA-C22.2 No.182.4, Plugs, Receptacles and Connectors for Communication Systems.

.2 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).

.3 Electronic Industries Alliance (EIA) / Telecommunications Industries Association (TIA)

.1 TIA/EIA/ANSI – 568-B.1/2/3 latest revision Commercial Building Telecommunications Cabling Standards for Telecommunications Pathways and Spaces;

.2 TIA/EIA/ANSI – 515000 Generic Specification for Optical Fibre and Cable Splices

.3 TIA-568-C.0 Generic Telecommunications Cabling for Customer Premises;

.4 TIA-568-C Series Commercial Building Telecommunications Cabling Standard;

.5 TIA/EIA-569 Commercial Building Standard for Telecommunications Pathway and Spaces;

.6 TIA/EIA-606 The Administration Standard for the Telecommunications Infrastructure of Commercial Building;

.7 TIA/EIA-607-A Commercial Building Ground (Earthing) and Bonding Requirements for Telecommunications;

.8 Category 6A system and testing as released by TIA/EIA/ANSI – latest revision

.9 TIA/EIA T568-A UTP wiring/pinout

.4 Other Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with:

.1 Section 01 33 00 - Submittal Procedures

.2 Section 26 05 01 – Common Work Results

.2 Submit shop drawings for review prior to ordering equipment. Shop drawings shall include but not be limited to, photocopies of accredited installers, copper termination jacks, and sample labeling.

1.4 PRODUCT APPROVALS

.1 Manufacturers' and model numbers named in these specifications indicate an acceptable technical standard of performance and are not intended to be exclusive. Products submitted as alternates must result in a control system that meets or exceeds all technical performance criteria as described.

.2 Products proposed as alternatives to those specified, shall only be considered if submitted for approval no later than 15 working days before tender close. Submit alternates, for approval, as one complete listing. Provide complete product specification sheets with request for approval.

.3 The Bidder must provide a complete list of primary system products offered with their bid.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.7 SYSTEM DESCRIPTION

.1 Termination, patch cords, and cross-connection equipment installed inside building for voice and data for telecommunications systems employing unshielded-twisted-pair (UTP) cables. Refer to drawings for details.

Part 2 Products

2.1 PATCH PANELS, CONNECTORS AND ADAPTORS

.1 Data and voice patch panels shall be 48-port panels mounted in the existing communication equipment racks in Room 003 in the basement. A minimum of 12 ports shall be spare for future. Patch panels shall be compatible with Category 6A installations, and shall accept snap-in non-keyed modular 8-pin jacks with T568-A pinout.

.2 Connectors shall be modular 8 PIN jacks, rated Category 6A –TIA/EIA T568-A UTP wiring/pinout. All data jacks shall be colour coded to match data cable colour identified in specifications. Connectors for data jacks designated as "Internet" on drawings shall be green.

Part 3 Execution

3.1 LABELLING

.1 Cable labels shall be self laminating labels as manufactured by Burndy or Panduit.

.2 Wall plates shall have integral labeling; self-adhesive labels will not be acceptable. Wall plates shall have self-adhesive icons adjacent to each jack of either a telephone or workstation to illustrate type of jack.

.3 Labeling shall be neatly typewritten and be in accordance with TIA 660. Cabling shall be labeled with the drop ID number at both termination points. Cable labeling shall be a logical numbering system of <room number> - <drop number>. Confirm if owner has special labeling system prior to installation. If owner has no set labeling system, confirm contractor suggested labeling with owner or consultant prior to any installation. The owner or consultant must sign off on labeling prior to installation; this sign-off shall be included in the maintenance manuals.

3.2 WARRANTY

.1 The contractor must make available to the Owner a local service department of a duly authorized distributor of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repair technician available to the Owner on 24 hours' notice.

.2 Provide warranty of installation of equipment installed by this contractor to be free of defects for a period of (1) one year from date of Substantial Completion.

.3 Provide during the warranty period, all service, maintenance, parts, etc., required for normal operation of the systems, such that Owner needs not purchase additional maintenance agreement or contracts. Upon request, the manufacturer and his agent shall provide direct to the Owner the following proposals:

.1 Continuation, after the warranty period, of full maintenance, including all service, labour, parts, etc. required to maintain the systems in a fully operational condition.

.4 During the warranty period, provide three (3) separate site visits of four (4) hours each on site for owner revisions and additional training.

3.3 VERIFICATION

.1 Perform tests in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check and test the entire system. Certification of all tests shall be submitted in writing to the Consultant and shall certify the following:

.1 That the system is complete in accordance with this specification

.2 That the system is installed in accordance with the manufacturer's best recommendations

.3 During the certification tests, the contractor shall provide one (1) electrician and (1) helper to assist the manufacturer's representative. The contractor shall also provide any required equipment such as ladders, scaffolding, etc.

3.4 TRAINING

.1 Perform training in accordance with:

.1 Section 26 05 01 - Common Works Results - Electrical

.2 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

Part 1 General

1.1 SYSTEM DESCRIPTION

.1 The intent of this specification is to provide a complete and satisfactory modular stand-alone sound masking system for the floors and areas identified on the drawings.

.2 The electrical contractor shall coordinate all installation requirements with the manufacturer prior to start of work on site.

.3 This electronics sound masking system shall be used for two basic purposes:

.1 To achieve a stated degree of speech privacy in the open office areas between adjacent and defined work stations.

.2 To unobtrusively mask or block out normal unwanted office noises.

.4 Electronic sound masking shall be used to achieve the appropriate background sound level in the open office areas. Masking shall provide uniform work privacy throughout the area without being readily apparent or objectionable to the open office occupants.

.5 It shall be the responsibility of the contractor to ensure that all necessary components are provided to result in a fully operational sound masking system.

.6 All equipment furnished shall be the standard products of the manufacturer.

.7 The sound masking system shall be a distributed direct field system.

1.2 PUBLIC ADDRESS SYSTEM INTEGRATION

.1 The sound masking system shall utilize speakers installed as part of the public address system as the transducers/emitters for the sound masking system. These speakers are denoted with a ‘SM’ on drawings. In normal operation, these speakers will be used as part of the sound masking system. Once a page is made from the commissionaire’s desktop microphone, the speakers will output the page before returning to sound masking mode. This mode switching is controlled by a digital signal processor. For further information on the digital signal processor and speakers, refer to drawings and public address specifications.

.2 The contractor shall coordinate the programming of the sound masking/public address system for the time period after a page has been completed and the system is returning to normal operation with sound masking present. The system shall be programmed such that the switch from paging to sound masking does not cause the sound masking sound to become noticeable under normal operation.

.3 The sound masking control modules / amplifiers as described below shall be used to power the speakers that output both sound masking audio and public address announcements. While testing audio levels, the contractor shall ensure that the speaker’s tap settings are well suited for both the sound masking application and public address intelligibility.

Part 2 Products

2.1 EQUIPMENT

.1 The system shall be comprised of three (3) zones with three (3) control modules. Refer to drawings for zone and module layout.

.2 Operation of zones shall be via a wireless infrared remote control with four (4) volume control preset buttons. Each module shall have two (2) output levels configured via an internal switch.

.3 Ranges shall be (30db – 88db) user selectable

.4 Ability for sound masking volume ramp-up over long periods of time. Minimum 3 week ramp up time.

.5 Control modules shall be power by the supplied wall adapter power supply.

.6 No more than 150 speakers shall be connected to each module.

.7 Control modules shall be the SmartSMS-NET RL200-8ch or approved equal.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment in accordance with the manufacturer's instructions and as indicated herein.

.2 Ceiling tiles shall be cut using the manufacturer recommended hole-saw bit.

.3 Electronic distribution to all transducers/emitters, shall be daisy chained via a FT6 plenum-rated enhanced Category 3 cable or other cable type as recommended by the manufacture. Refer to transducer/emitter criteria.

.4 Where equipment is located in storage room, mount in a separate enclosure or shelf. Confirm location for the enclosure or shelf on site.

.5 The level of sound masking shall be adjusted so that it is audible to a point but not distracting to room occupants. The effect shall be similar to the soft sound of moving air. Tuning reference shall be as per NIC curves.

.6 Conduct intelligibility test.

.7 The sound masking system shall be tuned for maximum speech privacy within designated areas. Tune the system with an appropriately calibrated acoustical instrumentation. Tuning shall comply with CSA 'guideline on office ergonomics' (doc #Z412-00).

.8 The contractor shall exercise caution, as necessary, to guard against electrostatic hum, and to install the equipment so as to provide maximum safety to non-technical operators.

.9 Provide for final demonstration of system to owner and consultant demonstrating compliance with requirements.

.10 On completion of the installation, all equipment and operations manuals shall be provide to the customer.

.11 In addition to the emitters/speakers shown on drawings, provide five (5) additional emitters/speakers c/w cable to be located on site after system is commissioned.

3.2 TRAINING

.1 At least two hours of training shall be provided to customer selected staff. Training shall include theory of operation, configuration and maintenance of the system.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 26 05 01 – Common Work Results – Electrical

.2 Section 27 05 28 – Pathways for Communication Systems

.3 Section 27 05 14 - Communication Cables Inside Buildings.

.4 Section 27 11 16 – Sound Masking

1.2 REFERENCES

.1 Contractor shall be bound by industry standards, as interpreted by the Consultant, whether or not specifically referenced in this document. Comply with Electrical Protection Act and rules and regulations made pursuant thereto, including the Canadian Electrical Code. Also, comply with applicable standards of the following:

.1 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.2 National Electrical Manufacturers Association (NEMA).

.3 Institute of Electrical and Electronic Engineers (IEEE).

.4 Audio Engineering Society (AES).

.5 Applicable Electrical Safety Codes, 2009 Canadian Electrical Code.

.6 Applicable CSA and UL approvals.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures and 26 05 01 – Common Work Results

.2 Shop drawings shall include but not be limited to, speakers, riser diagram, cable types, and special mounting details.

.3 System riser shall be submitted with the shop drawings. Riser shall include all cable, conduit, backbox, and rough in requirements for the system to ensure early coordination of supplier and contractor.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Meet requirements of Section 01 74 19 - Waste Management and Disposal.

.2 Collect and separate waste for reuse, recycling, and other waste diversion strategies in accordance with Waste Management Plan.

1.5 SYSTEM DESCRIPTION

.1 Provide the speakers and infrastructure for a fully operational public address system as herein specified.

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.2 It shall be the responsibility of the contractor to ensure that all necessary interconnecting wiring, etc., are provided to result in a fully operational system. The contractor shall be responsible for coordinating testing, schedule, rough-in, etc.

.3 The contractor shall exercise caution, as necessary, to guard against electrostatic hum, and to install the cabling so as to provide maximum safety to non-technical operators.

.4 The only input location shall be a desktop microphone located at the commissionaire's desk.

1.6 SOUND MASKING INTEGRATION

.1 All speakers denoted on drawings with suffix 'PA' shall be dedicated to the public address system only. These shall be powered through a public address amplifier as described below and in the drawings.

.2 All speakers denoted on drawings with suffix 'SM' shall be shared between the sound masking system and public address system. In normal operation these speakers shall output sound masking audio. Once a page is made from the commissionaire's desktop microphone the speakers will output the page before returning to sound masking mode. These speakers shall be powered by the sound masking control modules / amplifiers. Refer to sound masking specifications for further information.

1.7 CLOSEOUT SUBMITTALS

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

.1 Include:

.1 Operation instructions.

.2 Description of system operation.

.3 Description of each subsystem operation.

.4 List specifying each piece of equipment in system or subsystem by its original manufacturer name and model number.

.5 Part list specifying parts used in equipment by identification numbers that are standard to electronic industry.

1.8 SYSTEM STARTUP

.1 Manufacturer's representative to instruct:

.1 Maintenance personnel in maintenance of system.

.2 Operating personnel in use of system.

1.9 EXTRA MATERIALS

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

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Part 2 Products

2.1 MATERIALS

.1 Conduits: to Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Communication conductors: as indicated, to Section 27 05 14 - Communication Cables Inside Buildings.

2.2 COMPONENTS

.1 Distributed paging speakers shall be provided throughout the corridors and other areas. Speakers shall be provided and distributed throughout the facility as required to provide proper coverage. See drawing for speaker types and locations.

.2 Paging zones will be restricted to all-call only.

.3 The Contractor shall coordinate all requirements of the respective systems with the manufacturer and provide as required. The wiring of the speakers and phone sets shall be coordinated with the manufacturer and wired to suit the needs of the Owner.

.4 Upon completion of the installation, the contractor shall perform technical performance tests, in the presence of the consultant and to the consultant's satisfaction, that the system meets the performance criteria, as stated in this specification document and associated illustrations. The results of these tests shall be documented, in written form, noting all conditions at the time of tests and evaluation.

.5 All system components shall be grounded.

2.3 TYPE '1' - SUSPENDED CEILING SOUNDMASKING/PUBLIC ADDRESS SPEAKER

.1 Provide speakers suspended between/above ceiling locations as shown on the drawings. Exact locations of speakers shall be coordinated on site.

.2 Specifications:

Suspended speakers shall be 5" c/w back box/can and grill	
Frequency response:	100 Hz to 10 kHz
Sensitivity @ 1 W/M:	91 dB
Power rating:	10 W (xfmr)
Nominal impedance:	Integrated 70V: 8W, 4W
Color:	White
The technical standard of acceptance is Soft dB SMS-STR or approved equal	

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.3 Provide ten (10) additional speakers c/w 30m cabling, installation, and commissioning as spare.

2.4 TYPE '2' – RECESSED SOUNDMASKING/PUBLIC ADDRESS SPEAKER

.1 Provide speakers in t-bar and metal panel ceiling locations as shown on the drawings. Exact locations of speakers shall be coordinated on site. It shall be the responsibility of the contractor to coordinate all requirements of mounting speakers in metal panel ceilings.

.2 Specifications:

Ceiling mounted speakers shall be 5" co-axial bass reflex c/w back box/can and grill	
Beam width:	155^{o} conical, minimum
Frequency response:	80 Hz to 20 kHz
Sensitivity @ 1 W/M:	89 dB SPL
Power rating:	6W (70 V)
Nominal impedance:	Integrated 70V: 6W, 3W, 1.5W, 0.5W, 0.25W
Color:	White grill, paint to match décor.
The technical standard of acceptance is TOA electronics model F2352SC or approved equal	

.3 Cable length to be determined and adjustment on site. Paint cabinet and ceiling mount to match décor.

.4 Provide one (1) additional speaker c/w 30m cabling, installation, and commissioning as spare.

2.5 TYPE '3' – SURFACE WALL MOUNTED PUBLIC ADDRESS SPEAKER

.1 Specifications:

Ceiling mounted speakers shall be 4" dual cone bass reflex c/w white grill, mounted in new contractor supplied enclosure.	
Beam width:	170^{o} conical minimum
Frequency response:	67 Hz to 20 kHz
Sensitivity @ 1 W/M:	90 dB SPL (rated maximum) minimum
Power rating:	15 W continuous program
Nominal impedance:	Integrated 70V: 5W, 2W, 1W, 0.5W, 0.25W

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Color:	White
Backbox:	Maximum 4.3” deep
The technical standard of acceptance is Lowell CB44 or approved equal	

.2 Include white, steel, surface mounted speaker box.

2.6 TYPE ‘4’ – SURFACE WALL MOUNTED HORN PUBLIC ADDRESS SPEAKER

.1 Specifications:

Surface wall mounted horn style speaker	
Beam width:	70^{o} horizontal
Frequency response:	400 Hz to 7.5 kHz
Sensitivity @ 1 W/M:	105 dB SPL
Power rating:	15 W continuous
Nominal impedance:	Integrated 70V: 15W, 7.5W, 3.8W, 1.9W, 0.9W
Color:	White
The technical standard of acceptance is JBL CSS-H15 or approved equal	

2.7 PUBLIC ADDRESS AMPLIFIER

.1 Provide amplifiers with power ratings and technical performance such that each loudspeaker shall achieve the overall audio system performance specification stated. This amplifier will drive the speakers denoted on drawings as ‘PA’ only.

.2 Technical specifications shall include:

.1 Shall be modular power, two-channel or single channel amplifiers as required.

.2 All amplifiers shall be rack mountable.

.3 Have non-linear switching power supply

.4 Cooled by forced air.

.5 Have electronically balanced XLR inputs with an input impedance of 10Kohms or greater.

.6 Provide full short circuit protection and power monitoring capabilities.

.7 Capable of driving 70V loads

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.8 Provide adequate power capacity for all loudspeakers with added headroom of 3db SPL or greater for the specified loudspeakers.

.3 Acceptable products shall be those manufactured by Crown or approved equal.

2.8 DSP / MATRIX ROUTING

.1 Provide all required connections from existing DSP to the new public address amplifiers and sound masking control modules.

2.9 WALL MOUNTED AUDIO RACK

.1 Technical features shall include:

.1 Minimum 16U usable rack space

.2 Black powder coat finish

.3 Ventilation slots for air movement

.4 Removable back pan

.5 Double hinged, window door

.6 Horizontal mounting on threaded steel rails

.7 Bottom, top, and rear knockouts

.2 Mid Atlantic EWR series or approved equal.

2.10 CABLE AND CONNECTOR PANELS

.1 Provide all cable, wire and connectors for a complete and operational sound system.

.2 All cable for sound system to be PVC insulated, stranded pairs (or multi-conductor), as required. Provide shielded program (line level) cable, as required.

.3 Cable type and gauge shall be at the discretion of the Speaker supplier. However, all systems, when completed, must meet technical performance requirements, as specified.

.4 Provide all wiring terminal panels, terminal strips and cable wiring blocks. All connections, in sound panels and racks, shall be made with screw clamp terminal blocks.

.5 Loudspeaker cable to overhead speakers shall be #16 AWG stranded paired.

Part 3 Execution

3.1 INSTALLATION

.1 All wiring shall be in conduit. Division 26 is responsible for coordinating the rough in requirements with the suppliers of the systems.

.2 Review detailed shop drawings and wiring layouts provided by Speaker supplier.

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.3 Cable and conduit necessary to make the system operable shall be provided as instructed by the supplier of the Speaker system. The overall system coordination shall be the responsibility of the contractor, and they shall ensure that all of the necessary system components are installed to result in a complete, workable system. Where conduit sizes have been shown on the drawings larger than those recommended by the supplier, they shall not be reduced.

.4 All wiring shall be in separate EMT conduit utilized solely for public address/soundmasking, or within communication tray. Cabling shall be run in EMT conduit to within 305 mm of communication lay-in tray.

.5 Minimum wiring shall be FT6 Category 6 cabling for telephone sets. Minimum wiring shall be #18 gauge, PVC jacketed FT6 for other. Coordinate cable requirements with manufacturer and provide other cable if required. Any substituted cable type utilized shall not be lesser in quality or capability with the specified cable types. See section 27 05 14 - Communication Cables Inside Buildings.

.6 All interconnecting wiring terminations shall be made on numbered screw type terminal strips. Soldered, crimped or twisted connections will not be accepted.

.7 Rack terminations shall be made on internal termination panels.

.8 Provide all speaker and outlet terminations.

.9 All wiring installed in conduit shall be with a maximum conduit fill of 40%. Increase indicated conduit sizes, if necessary, to accommodate manufacturer's cable requirements

.10 Coordinate installation of equipment in and on millwork with millwork supplier and installer.

.11 No audio cable shall be installed adjacent to power cable or power conduit.

.12 All audio equipment shall be fixed mounted. This shall include loudspeakers, input and output jacks, switches and interconnecting cable.

.13 All loudspeaker fastenings and supports shall be of appropriate type to support loads with a safety factor of eight times their weight.

.14 Sufficient slack cable shall be left on termination at outlets to allow easy removal of panels for maintenance and re-wiring as necessary. Slack cabling shall be neatly coiled. All high signal level wiring shall be terminated on outlet connectors and terminal blocks.

.15 All wiring shall be neatly harnessed, with signal category segregation maintained throughout.

.16 Absolute phasing of all loudspeaker lines shall be maintained. The contractor must take such precautions as are necessary in a public building, and in this particular environment, to guard against electromagnetic and electrostatic hum and radio frequency interference. Proper mounting shall assure adequate amplifier equipment ventilation. Equipment shall be installed to provide maximum safety to non-technical operators.

.17 Exact locations of paging distributed speakers, and associated controls, shall be coordinated on site with the consultant.

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.18 Care shall be taken in wiring to avoid damage to cables, which might at a future date prove troublesome. All wiring shall be executed in strict adherence to professional industry standards, with due consideration to appropriate grounding and shielding practices

.19 All switches, connectors, input and outlet jacks, controls, etc., shall be clearly, logically, and permanently marked during installation. All markings on operating panels of equipment shall be 'Lamecoid' plates. Refer to Section 260 05 01 – Common Works Electrical.

.20 The system shall be checked for:

.1 Verification of color codes with respect to interconnections as recommended by the manufacturer

.2 Verification of color codes with respect to drawings and maintenance manuals

.3 Inspection of wiring and methods of termination in open junction boxes, backboxes for the devices and termination at control equipment

.4 Inspection of wiring and methods of termination in open junction boxes, backboxes for the devices and termination at control equipment;

.5 Designation of junction box covers and references with respect to these boxes on electrical drawings

.21 The system shall be tested for:

.1 Grounding

.1 System to building electrical ground;

.2 Cable shielding;

.3 Balance transmission lines above ground;

.2 Operation of system shall be checked step by step as described in user's manual

.3 Isolation of extraneous noises induced or otherwise, if present.

.22 Provide cable management and “waterfall” kits for cabling entering racks. Provide Velcro ties for bundled cabling, cable ties are unacceptable.

.23 All wiring shall be point to point and terminated directly onto the equipment or terminal strips that form part of the equipment.

.24 Provide a minimum of 200 mm of cable slack prior to termination to allow for future upgrades.

3.2 COMMISSIONING AND TESTING

.1 Commissioning shall be completed with the electrical consultant, electrical contractor, the Public Address System Supplier, owner representatives, and a manufacturer representative.

.2 The entire system shall be tested for ground loops.

□

.3 Refer to 26 05 01 for training requirements.

END OF SECTION

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Part 1 General

1.1 GENERAL REQUIREMENTS

.1 Wherever practical and reasonable, all cabinets and electrical boxes shall be installed in the locations shown on the attached floor plans.

.2 Drawings show conduit connection requirements. Actual conduit runs shall run parallel to building lines.

.3 Unless specified otherwise, all conduits shall be sized according to the number of cables in the run. Maximum conduit fill is 50%.

.4 Unless specified otherwise, all junction boxes (J1, J2, J3, etc.) shall be steel and sized according to the number of conduits they must accommodate.

.5 Unless noted otherwise, all cables pulled to a 'T' Type cabinet (T1, T2, T3, etc.) shall have no less than **2400mm** of cable slack in the 'T' cabinet.

.6 Unless noted otherwise, all cables terminating in a device or outlet box shall have no less than **600mm** of cable slack at the device/outlet box.

.7 All cables terminating in a cabinet, a splitter trough, a device box, a utility box or an outlet box shall be labelled.

.8 The contractor shall test all cables installed as part of this contract for opens, grounds and shorts. The contractor shall replace any cables found to be defective by the owner.

Part 2 Materials & Products

.1 Conduit

.1 Unless specified otherwise, all conduits shall be EMT.

.2 Junction, Outlet and Pull Boxes

.1 Unless specified otherwise, all outlet, device and pull boxes shall be steel.

.3 Cable

.1 All telephone type (Cat3) cables shall be NORDX D-INSIDE CABLE, **24 AWG**, CMR, Category 3 solid copper with a grey jacket (or equivalent).

.2 All Category 5e (Cat5e) cables shall be Belden 1213 D15 (or equivalent).

.3 All Category 6+ (Cat6+) cables shall be Belden 7852A D15 (or equivalent).

.4 All Category 6A (Cat6A) shielded cables shall be Belden 10GX62F 006 (or equivalent).

.5 All LVT cables shall be four (4) conductor #18 solid AWG Standard Control LVT cable.

.6 All 8 conductor overall shielded cable shall be General/Carol C0764A cable (or equivalent).

.7 All 15 conductor overall shielded cable shall be General/Carol C0766A cable (or equivalent).

.8 All two pair shielded cable shall be General/Carol C1352A (or equivalent).

.4 Pull Cord/Tape

.1 Polypropylene type, 200 lb tensile strength minimum.

Part 3 Execution

.1 **A4** Backboard

.1 Existing backboard with a splitter trough in Room 007.

.2 **A5** Backboard

.1 Supply and install 19mm G1S plywood backboard to cover all of the appropriate wall in Room 007 floor to ceiling (as per floor plans).

.2 Plywood backboard to be primed and painted to match adjacent walls.

.3 Supply and install one Hoffman AST383R 914W X 152H X 114Dmm splitter trough centered 2600mm A.F.F..

.4 Supply and install one duplex 120VAC receptacle 1800mm A.F.F. on the right-hand side of this backboard:

.5 Do not run 120VAC inside the splitter trough.

.6 This duplex receptacle shall be wired to a separate 120VAC circuit, on its own breaker, which is connected to emergency backup power (when available).

.7 Supply and install **two** structured wiring/data outlets mounted 50mm below the splitter trough.

.8 Provide structured cabling from the wiring/data outlets and terminate on a patch panel in the building's Server/Router rack.

.9 Provide patch cords and cross connect from patch panel to available ports on a data switch.

.10 Supply and install one Belden AX100495 FiberExpress Small Wall Mount Patch Panel centered 2400mm A.F.F. on the right-hand side of this backboard.

.11 Supply and install two Belden AX101409 FiberExpress Adapter Strips (loaded 6 SC Duplex Adapters) in the Belden FiberExpress patch panel.

.12 Supply and install one Middle Atlantic EWR-10-17 Wall Mount Rack centered 1800mm A.F.F. on the right-hand side of the backboard and below the Belden FiberExpress patch panel.

.13 Supply and install one Belden AX105520 CAT6+ 24-port Loaded Patch Panel in the Middle Atlantic rack.

.14 The plywood backboard space below the splitter trough is reserved for PTSS equipment. Do not run surface conduit in this area.

.3 **HA** Handicap Access Interface

.1 Supply and install conduit from electric door operator to a T2 cabinet in the area (as per floor plans).

.2 Supply and install **four** color coded #18 AWG conductors in the conduit from the door operator to the T2 cabinet as per attached schematic drawing "Access Control - Handicap Access Interface".

.3 Supply and install one ten position barrier terminal strip (Curtis 2010) in the T2 cabinet as per attached schematic drawing.

.4 Terminate conductors to terminals 6, 7, 9 and 10 in the T2 cabinet as per attached schematic drawing.

.5 Terminate conductors in door operator as per attached schematic drawing.

.4 **J1** Junction Box

.1 Supply and install one junction box above the suspended ceiling. If the ceiling is finished the junction box should be recessed on a wall 100mm below finished ceiling but no higher than 2400mm A.F.F.. Junction box shall be sized according to the number of conduits that must be accommodated.

.2 Supply and install conduit, sized to fit cables, from this junction box to another junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.5 **J3** Junction Box (200H X 200W X 100D)

.1 Supply and install one 200H X 200W X 100Dmm junction box 150mm above the suspended ceiling. If the ceiling is finished the junction box should be recessed on a wall 100mm below finished ceiling but no higher than 2400mm A.F.F..

.2 **Junction box must be accessible and serviceable**.

.3 Supply and install conduit, sized to fit cables, from this junction box to another junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.6 **J4** Junction Box

.1 Supply and install one junction box above the suspended ceiling. If the ceiling is finished the junction box should be recessed on a wall 100mm below finished ceiling but no higher than 2400mm A.F.F.. Junction box shall be sized according to the number of conduits that must be accommodated.

.2 Supply and install conduit, sized to fit cables, from this junction box to another junction box in the area **OR** to the splitter trough on the A5 backboard in Room 007 (as per floor plans).

.7 **T1** Existing "T" Cabinet (600H X 600W X 150D)

.1 Existing recessed 600H X 600W X 150Dmm Type 1 Telephone cabinet centered 1500mm A.F.F..

.2 Existing cables and equipment in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.3 All existing conduit and cabling terminating in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.8 **T2** "T" Cabinet (300H X 300W X 100D)

.1 Supply and install one 300H X 300W X 100Dmm Type 1 Telephone cabinet with wood back (BEL Products TCFKO12124WB or equivalent) **mounted 150mm above the suspended ceiling on the protected side of the wall**. If the ceiling is finished, the cabinet should be recess mounted 225mm above the strike side of the frame on the protected side of the wall. See attached detail drawings for Access Controlled doors.

.2 **Cabinet must be accessible and serviceable**.

.3 Supply and install conduit, sized to fit cables, from this cabinet to another T2 in the area **OR** to an X1 cabinet **OR** to a T1 cabinet **OR** to a T9 cabinet **OR** to a J3 junction box in the area (as per floor plans).

.4 An additional 13mm conduit **may** be required from the T2 cabinet to an alarm junction/outlet box in the area (as per floor plans).

.5 Supply, install and label **one** General/Carol C0764A cable and **one** 4 conductor **18 AWG** solid copper LVT cable in the conduit from the T2 cabinet to a T9 cabinet in the area.

.9 **T4** "T" Cabinet (450H X 450W X 150D)

.1 Supply and install one 450H X 450W X 150Dmm Type 1 Telephone cabinet surface mounted 150mm A.F.F.. **Surface mount the cabinet so that it remains accessible yet concealed by the Guard's console.**

.2 Supply and install one quad 120VAC receptacle in the top left corner inside this cabinet (mount receptacle on the side of the cabinet not the back). This quad receptacle shall be wired to a separate 120VAC circuit, on its own breaker, which is connected to emergency backup power (when available).

.3 Supply and install conduit from this cabinet to the splitter trough on the A5 backboard in Room 007.

.4 Supply, install and terminate **four** Belden 7852A D15 Category 6+ (Cat6+) cables in the conduit from this cabinet to the Belden AX105520 patch panel in the Middle Atlantic wall mount rack on the A5 backboard in Room 007.

.5 Supply no less than 4500mm of Cat6+ cable slack at the T4 cabinet.

.6 Supply and install one recessed quad 120VAC receptacle 600mm below finished ceiling on the wall directly above the T4 cabinet.

.10 **T5** Outdoor CCVE Enclosure

.1 Supply and install 32mm PVC conduit from this enclosure to the splitter trough on the A5 backboard in Room 007.

.2 Form and pour a 1200mm X 1200mm X 150mm concrete slab.

.3 Supply and install one Hammond 2CLS pedestal centered on the slab.

.4 Supply and mount one Batko FRI-191822H Outdoor Enclosure centered on the top of the 2CLS pedestal.

.5 Supply and install one quad 120VAC receptacle in the top left corner inside the enclosure. This receptacle shall be wired to a separate 120VAC circuit, on its own breaker, which is connected to emergency backup power (when available).

.6 Supply and install one Belden AX100041 FiberExpress 1U Rack Mount Patch Panel at the top of the rack rails inside the Batko Enclosure.

.7 Supply and install two Belden AX101409 FiberExpress Adapter Strips (loaded 6 SC Duplex Adapters) in the Belden FiberExpress patch panel.

.8 Supply, install and terminate one Belden B9W511T fiber cable between the FiberExpress Adapters in the Batko enclosure and the FiberExpress Adapters in the Belden patch panel on the A5 backboard in Room 007 in the basement of the building.

.9 Supply and install a Belden AX104563 10GX Shielded 24-port KeyConnect Patch Panel below the FiberExpress patch panel.

.11 **T9** "T" Cabinet (900H X 600W X 150D)

.1 Supply and install one 900H X 600W X 150Dmm Type 1 Telephone cabinet with 3/4" wood back (BEL Products TCFKO36246WB) beside an existing T1 cabinet (as per floor plan).

.2 Supply and install **one** structured wiring/data outlet in the bottom right corner inside this cabinet. Provide Cat5e cabling from the wiring/data outlet and terminate on a patch panel in a computer LAN Room managed by Informatics.

.3 Supply one empty 38mm conduit from the new T9 cabinet to the existing T1 cabinet.

.4 Supply, install and label **one** General C0764A cable and **one** 4 conductor **18 AWG** solid copper LVT cable in the conduit from the T9 cabinet to the splitter trough on the A4 backboard in Room 007. The existing conduit from the existing T1 cabinets to the A4 backboard in Room 007 can be used for this purpose.

.5 Supply no less than 6000mm of cable slack at the splitter trough on the A4 backboard in Room 007.

.12 **X1** Existing Access Control Cabinet (300H X 300W X 100D)

.1 Existing 300H X 300W X 100Dmm cabinet associated with the existing access control system.

.2 Existing cables and equipment in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.3 All existing conduit and cabling terminating in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.13 **X2** Existing Junction/Device/Outlet Box

.1 Existing junction/device/outlet box for existing alarm system.

.2 Existing cables and equipment in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.3 All existing conduit and cabling terminating in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.14 **01** Device Box

.1 Supply and install one recessed 76H X 100W X 63Dmm **double** gang device box c/w blank cover plate 150mm below finished ceiling but no higher than 2400mm A.F.F..

.2 Supply and install conduit from this device box to another device/junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.3 Supply, install and label **two** 4 pair telephone (Cat3) cables in the conduit from this outlet box to a T9 cabinet in the area.

.15 **11** Square Outlet Box

.1 Supply and have door-frame fabricator spot weld one 100H X 100W X **40**Dmm square outlet box on top of the frame as per attached detail drawing "PROTECTED DOOR - ELEVATION OF SINGLE DOOR WITH DOOR CONTACT".

.2 Drill a 19mm hole 75mm (center point) from the edge of the door casing to allow for door switch installation and access to frame mounted outlet box.

.3 Supply and install conduit from the outlet box in the door frame to a 76H X 50W X 63Dmm single gang pull box mounted above the door on the protected side of the wall. This pull box shall have a blank cover plate installed and shall be mounted above the suspended ceiling **OR** 100mm below the ceiling if the ceiling is finished.

.4 Supply and install conduit from the pull box to a device/junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.5 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the outlet box in the door frame to a T9 cabinet in the area.

.6 The cable slack at the outlet box in the door frame shall be tucked into the outlet box to protect the cable from damage.

.16 **12** Square Outlet Box

.1 Supply and have door-frame fabricator spot weld one 100H X 100W X **40**Dmm square outlet box on top of the door frame as per attached detail drawing(s) for access controlled doors.

.2 Drill a 19mm hole 75mm (center point) from the edge of the door casing to allow for door switch installation and access to frame mounted outlet box.

.3 Supply and install conduit from the outlet box in the door frame to a T2 cabinet **OR** to an X1 cabinet in the area (as per floor plan).

.4 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the outlet box in the door frame to the T2 cabinet **OR** to the X1.

.5 The cable slack at the outlet box in the door frame shall be tucked into the outlet box to protect the cable from damage.

.17 **14** Square Outlet Box

.1 Supply and have door-frame fabricator spot weld one 100H X 100W X **40**Dmm square outlet box on top of the door frame as per attached detail drawing(s) for access controlled doors.

.2 Drill a 19mm hole 75mm (center point) from the edge of the door casing to allow for door switch installation and access to frame mounted outlet box.

.3 Supply and install conduit from the outlet box in the door frame to a T2 cabinet in the area (as per floor plan)

.4 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the outlet box in the door frame to a T9 cabinet in the area.

.5 Supply, install and label a second 4 pair telephone (Cat3) cable in the conduit from this outlet box in the door frame **to the T2 cabinet**.

.6 The cable slack at the outlet box in the door frame shall be tucked into the outlet box to protect the cable from damage.

.18 **15** Utility Box

.1 Supply and install one surface mounted 76H X 60W X 50Dmm utility box c/w blank cover plate vertically oriented 2250mm above finished floor.

.2 Supply and install conduit from this utility box to a device/junction box in the area **OR** to the splitter trough on the A4 backboard (as per floor plans).

.3 Supply, install and label **two** 4 pair telephone (Cat3) cable in the conduit from this utility box to the A4 backboard.

.19 **21** Device Box

.1 Supply and install one recessed 76H X 150W X 63Dmm **three** gang device box c/w blank cover plate centered 1500mm A.F.F..

.2 Supply and install conduit from this device box to another device/junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.3 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from this device box to a T9 cabinet in the area.

.20 **31** Conduit to Electric Strike

.1 Supply and install conduit from a point 25mm above the strike plate inside the door frame to a T2 cabinet **OR** to an X1 cabinet in the area (as per floor plan).

.2 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the door frame to the T2 cabinet **OR** to the X1 cabinet.

.3 Leave 600mm of cable slack inside the door frame.

Note: For more more information, see attached detail drawing(s) for access controlled doors.
For more information, see attached detail drawing(s) for access controlled

doors.

.21 **33** Conduit to Abloy EA281 (for three hinge doors)

.1 Supply and install conduit from a point 450mm A.F.F. on the hinge side of the door frame to a T2 cabinet in the area (as per floor plans).

.2 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the frame **to the T2 cabinet**. Leave 610mm of slack outside of the frame/mullion.

.3 For more information, see attached access control detail drawing(s) for doors with electrified locksets or for doors with electrified panic hardware.

.4 The EA281 shall be supplied and installed by the door frame fabricator.

.5 Information Sheets have also been attached for the Abloy EA281 Power Transfer Lead Cover. These sheets have been provided for your information only.

.22 **41** Octagon Outlet Box

.1 Supply and install one 4" octagon outlet box **located no more than 300mm above** the suspended ceiling. If the ceiling is finished, the outlet box should be recess mounted and supplied with a cover plate.

.2 Supply and install conduit from this outlet box to a device/junction box in the area **OR** to a T9 cabinet in the area (as per floor plans).

.3 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from this outlet box to a T9 cabinet in the area.

Note: Supply no less than 3600mm of cable slack at the outlet box.

.23 **44** Device Box

.1 Supply and install one recessed 76H X 50W X 63Dmm single gang device box c/w blank cover plate centered 100mm above the top of the door frame on the protected side of the wall as per attached detail drawing(s) for access controlled doors.

.2 Supply and install conduit from this device to a T2 cabinet **OR** to an X1 cabinet in the area (as per floor plans).

.3 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from this device box to the T2 cabinet **OR** to the X1 cabinet.

Note: For more information, see attached detail drawing(s) for access controlled doors.

.24 **52** Junction Box

.1 Supply and install one recessed 200H X 200W X 100Dmm junction box centered 610mm A.F.F..

.2 Junction box must be accessible and serviceable.

.3 Supply and install 25mm conduit from this device box to an X2 junction box in the area (as per floor plans).

.4 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from this device box to the X2 junction box.

.5 Supply no less than 3600mm of cable slack in this junction box.

.25 **61** Device Box

.1 Supply and install one recessed 76H X 50W X 63Dmm single gang device box c/w blank cover plate centered 1300mm A.F.F..

.2 Supply and install conduit from this device box to a T2 cabinet **OR** to an X1 cabinet in the area (as per floor plans).

.3 Supply, install and label **one** General/Carol C0764A cable in the conduit from this device box to the T2 cabinet **OR** to the X1 cabinet.

Note: For more information, see attached detail drawing(s) for access control on doors with wall mounted readers.

.26 **62** Conduit to Frame/Mullion Mounted Device

.1 Supply and install conduit from a point 1375mm A.F.F. inside the frame/mullion to a T2 cabinet in the area (as per floor plans).

.2 Drill a 13mm hole in the frame/mullion, **on the unprotected side**, at a point 1300mm A.F.F..

.3 Supply, install and label **one** General C0764A cable from the hole in the frame/mullion **to the T2 cabinet**. Leave 610mm of slack outside of the frame/mullion.

.4 For more information, see attached detail drawing(s) for access control on doors with frame mounted readers or on double doors with mullion mounted readers.**81 Octagon Ceiling Mounted Outlet Box (2-1/8" Deep)**

.5 Supply and install one recessed 4" octagon outlet box, 2-1/8" deep, c/w blank cover plate in the ceiling. If ceiling is suspended, the octagon outlet box shall be located 305mm **above** the suspended ceiling.

.6 Supply and install conduit from this outlet box to a device/junction box in the area **OR** to the splitter trough on the A5 backboard in Room 007 (as per floor plans).

.7 Supply, install and terminate **two** Belden 7852A D15 Category 6+ cables in the conduit from the outlet box to the Belden AX105520 patch panel in the Middle Atlantic rack on the A5 backboard in Room 007.

.8 Supply no less than 600mm of cable slack at the outlet box.

.27 **86** Junction Box

.1 Supply and install one Hoffman A806CHNF 152W X 203H X 89Dmm Type 4 Junction Box. Mount 3000mm above concrete sidewalk or above ground level on the exterior side of the building.

.2 Supply and install conduit from this junction box to another junction/device box in the area (as per floor plans).

.3 Supply, install and terminate **four** Belden 7852A D15 Category 6+ cables in the conduit from this junction box to the Belden AX105520 patch panel in the Middle Atlantic rack on the A5 backboard in Room 007.

.4 Supply no less than 1200mm of cable slack at the junction box.

.28 **87** Pole Mounted Cabinet

.1 Supply and install one Axis T98A18-VE Surveillance Cabinet mounted on the pole 4500mm above ground level with an Axis T95A67 Pole Bracket.

.2 Supply and install PVC conduit from this surveillance cabinet to another surveillance cabinet in the area **OR** to the T5 CCVE enclosure in the parking lot (as per floor plans).

.3 Supply, install and label **two** Belden 10GX62F 006 Category 6A shielded cables in the conduit from this cabinet to the Belden AX104563 patch panel in the T5 outdoor CCVE enclosure in the parking lot.

.4 Terminate the Cat6A shielded cables with Belden RVAMJKSME 10GX Shielded RevConnect Modular Jacks at the patch panel in the T5 outdoor CCVE enclosure.

.5 Supply no less than 600mm of cable slack at the pole mounted cabinet.

.6 Terminate the Cat6A shielded cables with Belden RVAFPME 10GX Shielded RevConnect Modular Plugs at the pole mounted cabinet.

.29 **93** Device Box for Intercom Station

.1 Supply and install one recessed 76H X 50W X 63Dmm single gang device box c/w blank cover plate centered 1500mm A.F.F..

.2 Supply and install conduit from this device box to another device/junction box in the area **OR** to the intercom master junction box (as per floor plans).

.3 Supply, install and label **one** General C0764A cable in the conduit from this device box to the intercom master junction box.

.30 **94** Intercom Master Junction Box (200H X 200W X 100D)

.1 Supply and install one recessed 200H X 200W X 100Dmm junction box centered 610mm A.F.F..

.2 Junction box must be accessible and serviceable.

.31 **96** Existing Intercom Station Device Box

.1 Existing device box for existing intercom system.

.2 Supply and install conduit from this device box to another device/junction box in the area **OR** to the intercom master junction box (as per floor plans).

.3 Supply, install and label **one** General C0764A cable in the conduit from this device box to the intercom master junction box.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 Wherever practical and reasonable, all cabinets and electrical boxes shall be installed in the locations shown on the attached floor plans.

.2 Drawings show conduit connection requirements. Actual conduit runs shall run parallel to building lines.

.3 Unless specified otherwise, all conduits shall be sized according to the number of cables in the run. Maximum conduit fill is 50%.

.4 Unless specified otherwise, all junction boxes (J1, J2, J3, etc.) shall be steel and sized according to the number of conduits they must accommodate.

.5 Unless noted otherwise, all cables pulled to a 'T' Type cabinet (T1, T2, T3, etc.) shall have no less than **2400mm** of cable slack in the ‘T’ cabinet.

.6 Unless noted otherwise, all cables terminating in a device or outlet box shall have no less than **600mm** of cable slack at the device/outlet box.

.7 All cables terminating in a cabinet, a splitter trough, a device box, a utility box or an outlet box shall be labelled.

.8 The contractor shall test all cables installed as part of this contract for opens, grounds and shorts. The contractor shall replace any cables found to be defective by the owner.

Part 2 Materials and Products

.1 Conduit

.1 Unless specified otherwise, all conduits shall be EMT.

.2 Junction, Outlet and Pull Boxes

.1 Unless specified otherwise, all outlet, device and pull boxes shall be steel.

.3 Cable

.1 All telephone type (Cat3) cables shall be NORDX D-INSIDE CABLE, **24 AWG**, CMR, Category 3 solid copper with a grey jacket (or equivalent).

.2 All Category 5e (Cat5e) cables shall be Belden 1213 D15 (or equivalent).

.3 All Category 6+ (Cat6+) cables shall be Belden 7852A D15 (or equivalent).

.4 All Category 6A (Cat6A) shielded cables shall be Belden 10GX62F 006 (or equivalent).

.5 All LVT cables shall be four (4) conductor #18 solid AWG Standard Control LVT cable.

.6 All 8 conductor overall shielded cable shall be General/Carol C0764A cable (or equivalent).

.7 All 15 conductor overall shielded cable shall be General/Carol C0766A cable (or equivalent).

.8 All two pair shielded cable shall be General/Carol C1352A (or equivalent).

.4 Pull Cord/Tape

.1 Polypropylene type, 200 lb tensile strength minimum.

Part 3 Execution

.1 T2 "T" Cabinet (300H X 300W X 100D)

.1 Supply and install one 300H X 300W X 100Dmm Type 1 Telephone cabinet with wood back (BEL Products TCFKO12124WB or equivalent) **mounted 150mm above the suspended ceiling on the protected side of the wall**. If the ceiling is finished, the cabinet should be recess mounted 225mm above the strike side of the frame on the protected side of the wall. See attached detail drawings for Access Controlled doors.

.2 **Cabinet must be accessible and serviceable.**

.3 Supply and install conduit, sized to fit cables, from this cabinet to an X1 cabinet in the area (as per floor plans).

.4 Supply, install and label **one** General/Carol C0764A cable and **one** 4 conductor **18 AWG** solid copper LVT cable in the conduit from the T2 cabinet to the X1 cabinet.

.2 X1 Existing Access Control Cabinet (300H X 300W X 100D)

.1 Existing 300H X 300W X 100Dmm cabinet associated with the existing access control system.

.2 Existing cables and equipment in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.3 All existing conduit and cabling terminating in this cabinet are not to be disturbed and are to be protected from damage during demolition and construction.

.3 12 Square Outlet Box

.1 Supply and have door-frame fabricator spot weld one 100H X 100W X **40**Dmm square outlet box on top of the door frame as per attached detail drawing(s) for access controlled doors.

.2 Drill a 19mm hole 75mm (center point) from the edge of the door casing to allow for door switch installation and access to frame mounted outlet box.

.3 Supply and install conduit from the outlet box in the door frame to a T2 cabinet in the area (as per floor plan).

.4 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the outlet box in the door frame to the T2 cabinet.

.5 The cable slack at the outlet box in the door frame shall be tucked into the outlet box to protect the cable from damage.

.4 **31 Conduit to Electric Strike**

.1 Supply and install conduit from a point 25mm above the strike plate inside the door frame to a T2 cabinet in the area (as per floor plan).

.2 Supply, install and label **one** 4 pair telephone (Cat3) cable in the conduit from the door frame to the T2 cabinet.

.3 Leave 600mm of cable slack inside the door frame.

Note: For more information, see attached detail drawing(s) for access controlled doors.

.5 **61 Device Box**

.1 Supply and install one recessed 76H X 50W X 63Dmm single gang device box c/w blank cover plate centered 1300mm A.F.F..

.2 Supply and install conduit from this device box to a T2 cabinet in the area (as per floor plans).

.3 Supply, install and label **one** General/Carol C0764A cable in the conduit from this device box to the T2 cabinet.

Note: For more information, see attached detail drawing(s) for access control on doors with wall mounted readers.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 26 05 01 - Common Work Results - Electrical.

1.2 REFERENCES

.1 NBC – 2010, National Building Code of Canada

.2 CSA C22.1-12, Canadian Electrical Code, Part 1, 2015

.3 All equipment shall be listed by Underwriters' Laboratory of Canada. The entire installation shall be in full compliance with the 2010 National Building Code, 2015 Canadian Electrical Code, National Standard of Canada/Underwriters' Laboratory of Canada Standards, and the Saskatchewan Human Rights Commission, Accessibility Standard.

.4 National Standard of Canada/Underwriters' Laboratories of Canada Standards:

.1 CAN/ULC-S524-M06, Installation of Fire Alarm Systems

.2 CAN/ULC-S525-99, Audible Signal Devices

.3 CAN/ULC-S526-02, Visual Signal Devices

.4 CAN/ULC-S528-05, Manual Stations for Fire Alarm Systems including Accessories

.5 CAN/ULC-S529-02, Smoke Detectors

.6 CAN/ULC-S536-04, Inspection and Testing of Fire Alarm Systems

.7 CAN/ULC-S537-04, Verification of Fire Alarm Systems

1.3 DESCRIPTION OF SYSTEM

.1 The existing Notifier computer based fire alarm system shall remain in operation throughout the facility during the renovations.

.2 Complete the alterations to the existing fire alarm system within the renovation areas that includes installation of sound amplifiers and cabinets, booster panels, automatic detection devices, signal devices, fire modules and other auxiliary devices as shown on the floor plans and noted herein.

.3 Provide new fire alarm devices and equipment as indicated on the drawings and described in these specifications.

.4 Relocate and reconnect existing fire alarm devices as indicated on the floor plans.

.5 New Code Spear System: The existing fire alarm horn/strobe signal devices shall be removed and the fire alarm system shall be revised to an emergency voice communication evacuation system, using speaker and speaker/strobe devices.

.1 The existing horn/strobe signaling system shall remain operational throughout the renovation until the new emergency voice communication evacuation system is operational.

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.2 Provide new speakers and speaker/strobes within the renovation areas as located on the floor plans to be revised to an emergency voice communication evacuation system throughout the building. Provide the necessary wire of the signal appliances in a separate conduit from existing within the renovation areas.

.3 An existing network fiber cable connection is provided to the existing fire alarm control panel in Room 006 from the owner's central monitoring centre outside the building, and shall remain. This network fiber cable connection will be used by the owner to provide voice and audible communications broadcasts on the fire alarm system for the Code Spear system. Provide necessary modifications and terminations of the fibre connections to the fire alarm system to receive and broadcast Code Spear communications on the fire alarm system.

.6 Existing speakers and speaker/strobe devices have been provided in the previous construction phase as shown on drawings.

.1 These speakers and speaker/strobes are not currently connected into the fire alarm system. Wiring has been provided to the devices and run to junction boxes outside the renovation area of that previous construction phase and left unterminated. Access to the previously renovated areas is very limited and shall be coordinated with owner to be done outside normal office hours.

.2 This contractor shall locate these junction boxes, complete the terminations, and extend and connect the wiring into the main fire alarm control panel.

.3 Connect and verify these speakers and speaker/strobes along with new devices into the new Emergency voice communication evacuation system to form a complete system for the entire building.

.7 Relocate the existing fire alarm remote annunciator as shown in Room 102, to be flush mounted in new wall. From the existing main fire alarm panel in Basement Room 004 to the new location, run 2 pairs of #16 twisted shielded Securex cables and 1 pair of #14 pair twisted shielded Securex cable for the annunciator, and 2 pair of #16 twisted shielded Securex cables for the new paging microphone. Confirm existing cabling on site.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

.1 Fire Alarm System:

.1 In accordance with the Authority Having Jurisdiction

.2 System components: listed by ULC and comply with applicable provision of National Building Code and meet requirements of local authority having jurisdiction.

1.5 SYSTEM OPERATION

.1 The operation of the existing 2-stage addressable fire alarm system has been revised. The fire alarm system shall be re-programmed to provide zero delay between the pre-signal alert and alarm stage, such that the fire alarm system operates as a single stage system.

.2 If an alarm is caused by activation of any of the following devices:

.1 Pulling a manual station;

.2 Operating of a sprinkler flow switch;

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.3 Operation of an automatic fire alarm thermal detector;

.4 Operation of a smoke detector (ceiling or duct mounted);

.5 Operation of the sprinkler pre-action systems;

The following shall occur:

.1 An audible alarm shall sound on all signal appliances through the building with the signal alarm generated on the fire alarm system. Strobe lights installed as visual alarms shall flash.

.2 The annunciator panels throughout the facility shall display the alarm location (fire zone), alarm type (pull station, smoke detector, sprinkler, thermal, etc.) location description along with time.

.3 The alarm shall continue until the alarm is acknowledged and the system is silenced. The device causing the alarm shall cause the systems to remain in alarm until the device is cleared or reset, and the system alarm is acknowledged.

.4 The existing signal sent to each elevator controllers to home elevators to the main floor shall remain.

.5 The automatic signal from the system to the municipal fire department or owner's monitoring system via the fire alarm system shall remain.

.6 The existing signals sent to activate the ventilation systems in the correct sequence for the fire zone causing the alarm condition shall remain..

.7 Release all magnetic door holders in the building.

.8 The existing signal from the fire alarm system to the access door control systems in the building to disengage electromagnetic locks allowing fail-safe and free egress for doors controlled by the access control systems shall remain.

.9 The operator will acknowledge the alarm. Input/output device designation, data and time shall be printed, indicating the alarm has been acknowledged.

.10 A subsequent alarm from any receiving circuit (device) shall cause the audible signals to sound again. Subsequent alarms shall be displayed on the network annunciators in order of priority and then in the order in which they occur. Subsequent alarms may occur prior to acknowledgement of initial alarm.

.11 The evacuation alarm shall continue until the alarm is acknowledged and the system is silenced. The device causing the alarm shall cause the system to remain in alarm until the device is cleared or reset, and the system is acknowledged.

.3 The entire system shall be electrically supervised against opens, shorts and grounds of any wire on the alarm initiating circuits or any wire on the signal circuits. Trouble conditions shall display as a lower priority than an alarm.

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.4 All new points shall be included in the computer software program, and the software program shall be regenerated twice. This first regeneration shall be provided during the completion of the addition and renovations. The second regeneration shall be provided approximately three months after the first regeneration and shall reflect any contract changes and any owner initiated changes.

.5 Maintain the existing interconnection to the telephone system to signal the municipal fire department and owner's monitoring centre on activation of the fire alarm system.

.6 Maintain the existing wiring and controls that have been provided to accommodate fire alarm interconnections with the sprinkler and mechanical control systems.

.7 The existing interconnection to the elevator controllers to home elevators on activation of the building fire alarm system shall be maintained.

.8 All new fire alarm equipment shall be powered from a single source connected to dedicated circuits fed from the existing emergency power supply system unless otherwise noted.

1.6 SPRINKLER PROTECTION SYSTEMS

.1 Existing sprinkler, and sprinkler pre-action assemblies present within the facility shall remain. The existing connections, monitoring and control of the existing pre-action systems shall be maintained during the construction period. Sprinkler pre-action systems equipped with 120-volt AC solenoid valve (fed from emergency or uninterrupted power supplies, non-supervised circuits) or 24-volt DC solenoid valves (fed from the existing fire alarm panel or remote power booster panel, supervised circuits) shall remain and be maintained. Existing monitor modules connected to the tamper switch or shut-off valve shall remain, and the relay module installed to release the solenoid valve shall remain. Where installed, existing monitor modules for loss of air pressure (supervisory alarm) and water flow (initiating device) shall remain.

1.7 SHOP DRAWINGS

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

.2 Shop drawings shall include but not be limited to complete floor plans, riser, equipment, control schematics and wiring diagrams. Each component shall be identified as to manufacture, type, description and catalogue number.

1.8 CLOSEOUT SUBMITTALS

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

.2 Include:

.1 Overall system riser wiring diagram identifying control equipment, initiating addresses, signalling circuit; identifying terminations, terminal numbers, conductors and raceways.

.2 Details and performance specification of devices added for control, annunciation and peripherals with item by item cross reference to specification for compliance.

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.3 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.

.4 Technical data - illustrated parts lists with parts catalogue numbers.

.5 Copy of approved shop drawings.

.6 List of recommended spare parts for system.

.7 Certification of tests, upon completion, shall be issued in writing to the Consultant by the manufacturer's representative.

1.9 SPARE DEVICES

.1 Provide the following spare devices with 10 meters of conduit and wire per device, back boxes, installation, testing, verification, etc:

.1	Monitor Modules	4
.2	Control Modules	2
.3	Relay Modules	5
.4	Fault Isolator Modules	8
.5	Speakers (Ceiling)	4
.6	Speaker/Strobe (Ceiling)	8
.7	Flush Speaker Box Adapter Plates	8
.8	Speaker/Strobes (surface wall mount)	4

1.10 MAINTENANCE

.1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Engineer.

Part 2 Products

2.1 MATERIALS

.1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.

.1 Fire Alarm Booster Panels

.2 Emergency voice communication evacuation equipment, amplifiers, cabinets and power supplies

.3 Detectors

.4 Monitor and Relay Modules

.5 Fault Isolator Modules

.6 Audible Speakers and Visual Signal Strobe Appliances

.2 All devices shall be installed in outlet boxes

.3 All wiring runs in conduit raceway.

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.4 All new equipment and devices shall be manufactured by **Notifier** as supplied by Alsask Fire Equipment.

.5 The new materials are as specified herein.

2.3 DEVICES

.1 **Detectors:** Provide multi-sensor low-profile intelligent detectors designed to increase immunity to false alarms. The detectors shall be microprocessor-based, combination photoelectric and thermal technology, addressable analog type detector. The detector shall adjust its sensitivity automatically without needing operator intervention or control panel programming. The thermal sensing rating shall be fixed-temperature set point 135°F (57°C). Includes LED red indicator when in alarm; flashes green in standby for normal conditions.

.2 **Monitor, Control and Relay Modules:** Provide addressable monitor, control and relay modules to interface to convenience non-addressable devices.

.1 Monitor modules shall be installed to supervise a circuit of dry-contact input devices, such as conventional heat detectors and pull stations, or monitor and power a circuit of two-wire smoke detectors. Powered directly by the SLC loop, high-noise (EMF/RFI) immunity, LED flashes green for normal operation and latches on steady red to indicate alarm.

.2 Control modules provide the control panels a circuit for operating horns, strobes, speakers, etc., or to monitor a telephone circuit. Addressability allows the control module to be activated, either manually or through panel programming on a select zone or area of coverage. LED blinks green each time a communication is received from the control panel and turns on in steady red when activated.

.3 Relay modules provide the system with a dry-contact output for activating a variety of auxiliary devices, such as fans, dampers, control equipment, etc. Addressability allows the dry contact to be activated, either manually or through panel programming. LED blinks green each time a communication is received from the control panel and turns on in steady red when activated.

.3 **Fault Isolators:** Provide fault isolator modules to detect and isolate short-circuited segments on the SLC loops. The module shall automatically determine a return-to-normal condition of the loop and restore the isolated segment. Integral LED blinks to indicate normal condition, illuminates steady when short circuit condition is detected. Provide fault isolator modules on each loop after every (20) twenty devices and after every floor penetration or penetrations of fire barriers.

.4 The plug-in module shall be supervised against removal, improper module position and incorrect module type. The control panel shall provide absolute electronic protection of all circuitry such that any module may be inserted or removed, while the control panel is fully powered without causing an alarm condition or any damage to the equipment.

.5 **End of Lines:** End-of-line devices for signalling zones and sprinkler flows and tampers shall be mounted in separate single gang box with red cover plate.

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.6 **Speaker and Speaker Strobes for New Code Spear System:** Audible and visual signaling appliances shall be provided to meet code requirements, ADA/NFPA/ANSI compliant, and shall be ULC listed for the purpose of fire alarm signaling and emergency voice communication. The signal device shall be separate speaker, combination speaker/strobe, and shall be flush mounted in suspended T-bar ceilings or surface wall mounted types as indicated on the floor plans.

.7 The fire alarm control panel shall produce the required temporal pattern audible output to be broadcast through the speakers. The speakers shall operate on an input voltage of 25 or 70.7 Vrms. The speakers shall be the high fidelity type and shall have a frequency response of 100 Hz to 10,000 Hz even with a UL listing of only 400 Hz to 40,000 Hz. The speakers shall power taps of ¼, ½, 1 and 2 watts. The speakers shall have a minimum dBA output of approximately 78dBA at ¼ watt tap setting (UL Anechoic test).

.8 Initially set power tap to ¼ watt for all speakers.

.9 The synchronizing strobe shall produce white light with a minimum of 15 candela across all viewing angles in common areas, but shall be field selectable for other ratings.

.10 **Remote Paging Microphone:** Provide a new paging microphone located in the relocated main fire alarm control panel in Room 006, and in the annunciator panel in Room 102, to allow for emergency, fire, or general paging, or initiation of automatic messages.

Part 3 Execution

3.1 INSTALLATION

.1 The contractor must make available to the Owners a local service department of the equipment manufacturer, which shall stock the manufacturer's standard parts. The service department shall have at least one factory trained repairman available to the Owner on a 24 hours' notice. The systems shall be guaranteed for a period of one year. Refer to section 260501. Provide, during the guarantee period, all service, maintenance, parts, etc., required for the normal operation of the systems, such that the Owner need not purchase additional maintenance agreement or contracts. The manufacturer shall visit the jobsite a minimum of once every four (4) months during the guarantee period to perform above noted maintenance.

.2 The overall system co-ordination shall be the responsibility of the contractor, and he shall ensure that all of the necessary system components are installed to result in a complete, workable system.

.3 All field devices including manual pull stations, detectors, monitor, control and relay modules shall be externally labelled showing the address and device controlled and monitored. The self-adhesive identification labels shall be 12mm **WHITE** laminated marker tape with black typed lettering. Identification shall be placed on the inside of doors where doors are either controlled by magnetic door holders, electric locks, or magnetic locks.

.4 All ceiling mounted fire detection devices shall be installed as close as possible to the centre of the rooms, stair shafts and portions of the corridors, or as noted on the drawings. Detectors shall be mounted at highest point of area to be protected. Ensure that these detectors are sufficiently spaced from supply air diffusers, light fixtures, and other ceiling mounted items

that might block the movement of heat or smoke to the detectors. Smoke detectors shall not be located within 900mm of the peak of a vaulted ceiling.

.5 Detectors shall be mounted in suitable mounting plates with finish ring. Where shown in proximity to unit heaters, detectors shall be located at least 3000mm from such unit heaters, and out of line of direct heat. Detectors shall be located 1500mm from any air handling diffusers or grilles.

.6 Install T-bar mounting bars to support speaker and speaker strobes in suspended acoustic ceilings. In areas where t-bar ceilings are not present, speakers shall be suspended to the underside of the finished wood ceiling panels.

3.2 WIRING

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and CAN/ULC-S537.

.2 All wiring shall be color coded. Wire and conduit necessary to make the system operable shall be provided and installed as instructed by the manufacturer of the fire alarm system. All wiring shall be installed in conduit with a maximum conduit fill of 40%. All conduit shall be installed in accordance with Section 260534.

.3 Wiring shall be as follows:

.1 Wiring for signal strobe device circuits shall be a minimum #14 gauge RW90, 300 Volt, solid copper. Run in separate conduit from initiating circuits. Run speaker circuits on separate circuit from strobes.

.2 Wiring for speaker device circuits shall be #16 gauge RW90, 300 Volt, twisted shielded jacketed pair. Shielding must be continuous throughout and isolated from ground except at the control panel.

.3 Addressable devices shall be #18 gauge, twisted shielded jacketed pair. Shielding must be continuous throughout and isolated from ground except at the control panel. All existing shielded wiring being reused for the addressable loops shall be taped at every termination point.

.4 Ancillary circuits shall be #14 gauge RW90, 300 volt, solid copper. Run in separate conduit.

.5 Annunciator wiring shall be as per manufacturer's recommendations.

.4 All wiring and its installation must comply with all appropriate codes including CAN/ULC-S524-M06. Refer to Appendix 'A' of CAN/ULC-S524-M06 for further requirements.

.5 All boxes and panels shall be provided with Lamecoid labels for identification.

.6 All devices shall be installed in outlet boxes.

.7 All wiring shall be run in EMT conduit raceway.

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3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical and CAN/ULC-S537.

.2 Manufacturer shall allow for a required amount of on-the-job site assistance for the contractor during the construction period. Phasing of the construction project may require multiple site visits by the manufacturer, and some areas to be completed and verified prior to other areas being turned over.

.3 The entire installation shall be performed under the supervision of the manufacturer. Upon completion of the installation, the manufacturer shall check the entire system to the approval of the Consultant. The manufacturer shall verify the entire system and demonstrate its complete operation to those having jurisdiction. Verification shall include all new devices, existing devices and devices provided in the previous construction phase.

.4 The manufacturer shall perform a complete verification and inspection of all installed equipment, including each and every component, such as manual stations, automatic detectors, sprinkler switches, audible signalling appliances, station indicating lamps, control equipment, remote peripherals, etc., to ensure the following:

.1 That the type of equipment installed is that designated by the Consultant's specifications and plans;

.2 That the wiring connections to all equipment are correct and in accordance with CSA and ULC requirements;

.3 That the equipment is installed in accordance with the manufacturer's recommendations;

.4 That the regulations concerning the supervision of components have been adhered to (e.g. stations, detectors, signal devices, etc.), and are properly wired and supervised;

.5 That any subsequent changes necessary to conform to the above will be done by the contractor, with technical advice supplied by the manufacturer.

.5 During the period of inspection, the Contractor shall supply to the manufacturer, one (1) electrician and one (1) helper.

.6 The contractor shall also supply any required equipment such as ladders, scaffolding, etc.

.7 To assist the installer in preparing his bid, the manufacturer shall indicate the number of hours necessary to complete this inspection.

.8 Upon completion of the inspection, and when all of the above conditions have been compiled with, the manufacturer shall issue to the Consultant the following:

.1 A copy of the inspecting technician's report, showing the location of each device, and certifying the test results of each device.

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.2 A certificate of verification confirming that the inspection has been completed, and showing the condition upon which such inspection and certification have been rendered.

.3 Proof of liability insurance for the inspection.

.9 All verification certificates shall include the testing of the audibility of the signal devices to confirm compliance with the 2010 National Building Code.

3.4 TRAINING

.1 Arrange and pay for on-site lecture and demonstration by the fire alarm equipment manufacturer to train operational personnel in use and maintenance of the fire alarm system.

.2 The Owner's operating and maintenance personnel shall be instructed in the operation and maintenance of the system for a minimum period of one two-hour session.

.3 Written documentation bearing name and signature of Owner's personnel who received the above instructions shall be included in the operating instructions and service manuals.

END OF SECTION

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Part 1 General

1.1 NOT USED

.1 Not Used.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 STRIPPING OF TOPSOIL

.1 Ensure that procedures are conducted in accordance with applicable Municipal requirements.

.2 Remove topsoil before construction procedures commence to avoid compaction of topsoil.

.3 Handle topsoil only when it is dry and warm.

.4 Remove vegetation from targeted areas by non-chemical means and dispose of stripped vegetation by alternative disposal.

.5 Remove brush from targeted area by non-chemical means and dispose of through alternative disposal.

.6 Strip topsoil to depths as directed by Departmental Representative.

.1 Avoid mixing topsoil with subsoil.

.7 Pile topsoil in berms in locations as directed by Departmental Representative.

.1 Stockpile height not to exceed 3 m.

.8 Dispose of unused topsoil off-site in location as indicated by Departmental Representative.

.9 Protect stockpiles from contamination and compaction.

.10 Cover topsoil that has been piled for long term storage, with trefoil or grass to maintain agricultural potential of soil.

3.3 PREPARATION OF GRADE

.1 Verify that grades are correct and notify Departmental Representative if discrepancies occur. Do not begin work until instructed by Departmental Representative.

.1 Grade area only when soil is dry to lessen soil compaction.

3.4 PLACING OF TOPSOIL

.1 Place topsoil only after Departmental Representative has accepted subgrade.

.2 Spread topsoil during dry conditions in uniform layers not exceeding 200 mm, over unfrozen subgrade free of standing water.

.3 Establish traffic patterns for equipment to prevent driving on topsoil after it has been spread to avoid compaction.

.4 Cultivate soil following spreading procedures.

3.5 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 NOT USED

.1 Not Used.

1.2 REFERENCES

.1 ASTM International

.1 ASTM D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort m^3.

.2 Underwriters' Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

1.4 EXISTING CONDITIONS

.1 Examine subsurface investigation report which is available for inspection from Departmental Representative.

Part 2 Products

2.1 MATERIALS

.1 Excavated or graded material existing on site suitable to use as fill for grading work if approved by Departmental Representative.

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 rough grading installation in accordance with manufacturer's written instructions:

.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 GRADING

.1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

.2 Rough grade to following depths below finish grades:

.1 150 mm for grassed areas.

.2 350 mm for asphalt paving.

.3 Slope rough grade away from building 1:50 minimum.

.4 Grade ditches to depth as indicated.

.5 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum before placing fill over existing ground. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.6 Compact filled and disturbed areas to maximum dry density to ASTM D698, as follows:

.1 85% under landscaped areas.

.2 95% under paved and walk areas.

.7 Do not disturb soil within branch spread of trees or shrubs to remain.

3.3 TESTING

.1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid for by Contractor.

.2 Density testing of fill: one test for each 500 square metres for each 150 mm compacted lift.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse or recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

.1 Protect existing fencing, trees, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as directed by Departmental Representative. If damaged, restore to original or better condition unless directed otherwise.

.2 Maintain access roads to prevent accumulation of construction related debris on roads.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Definitions:

.1 Rock Excavation: excavation of:

.1 Material from solid masses of igneous, sedimentary or metamorphic rock which, prior to removal, was integral with parent mass. Material that cannot be ripped with reasonable effort with a Caterpillar D9 crawler bulldozer or equivalent to be considered integral with parent mass.

.2 Boulder or rock fragments measuring in volume 1 cubic metre or more.

.2 Common Excavation: excavation of materials that are not Rock Excavation or Stripping.

.3 Unclassified Excavation: excavation of whatever character other than stripping encountered in the Work.

.4 Free Haul: distance that excavated material is hauled without compensation. Free haul distance to be 1.0 km or less.

.5 Stripping: excavation of organic material covering original ground.

.6 Over Haul: authorized hauling in excess of free haul distance that excavated material is moved.

.7 Embankment: material derived from usable excavation and placed above original ground or stripped surface up to top of subgrade.

.8 Waste Material: material unsuitable for embankment, embankment foundation or material surplus to requirements.

.9 Borrow Material: material obtained from areas outside right-of-way and required for construction of embankments or for other portions of work.

.10 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

.2 Reference Standards:

.1 ASTM International

.1 ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

.1 Regulatory Requirements:

.1 Adhere to regulations of authority having jurisdiction when blasting is required.

.2 Adhere to Provincial and National Environmental requirements when potentially toxic materials are involved.

Part 2 Products

2.1 MATERIALS

.1 Embankment materials require approval by Departmental Representative.

.2 Material used for embankment not to contain more than 3% organic matter by mass, frozen lumps, weeds, sod, roots, logs, stumps or other unsuitable material.

.3 Borrow material:

.1 Obtain from sources such as quarry, or borrow pit.

.1 Earth Embankment materials to consist of acceptable earth material and processed rock material free from objectionable quantities of organic matter, frozen soil, stumps, trees, moss, and other unsuitable materials.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify that condition of substrate is acceptable for roadway embankment Work:

.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 COMPACTION EQUIPMENT

.1 Compaction equipment: vibratory rollers or vibrating plate compactors capable of obtaining required density in materials on project.

.1 Replace or supplement equipment that does not achieve specified densities.

.2 Operate compaction equipment continuously in each embankment when placing material.

3.3 WATER DISTRIBUTORS

.1 Apply water with equipment capable of uniform distribution.

3.4 EXCAVATING

.1 General:

.1 Notify Departmental Representative when waste materials are encountered and remove to depth and extent directed.

.2 Treat ground slopes, where subgrade is on transition from excavation to embankment, at grade points as directed by Departmental Representative.

.3 Dispose of excess material offsite.

.2 Drainage:

.1 Maintain profiles, crowns and cross slopes to provide good surface drainage.

.2 Provide ditches as work progresses to provide drainage.

.3 Construct interceptor ditches as indicated or as directed before excavating or placing embankment in adjacent area.

.3 Rock excavation:

.1 Notify Departmental Representative, when material appearing to conform to classification for rock is encountered, to enable measurements to be made to determine volume of rock. Provide 48 hour notification.

.4 Borrow Excavation:

.1 Completely use in embankments, suitable materials removed from right-of-way excavations before taking material from borrow areas.

.2 Where imported embankment material is required, Contractor to arrange and pay for all imported material. Obtain embankment materials, in excess of what is available from cut areas, from designated borrow areas.

3.5 EMBANKMENTS

.1 Scarify or bench existing slopes in side hill or sloping sections to ensure proper bond between new materials and existing surfaces.

.2 Break up or scarify existing road surface prior to placing embankment material.

.3 Do not place material which is frozen nor place material on frozen surfaces except in areas authorized by Departmental Representative.

.4 Maintain crowned surface during construction to ensure ready run-off of surface water.

.5 Drain low areas before placing materials.

.1 Place and compact to full width in layers not exceeding 200 mm loose thickness. Departmental Representative may authorize thicker lifts if specified compaction can be achieved and if material contains more than 25% by volume stone and rock fragments larger than 100 mm.

.6 Deductions from excavation will be made for overbuild of embankments.

3.6 COMPACTION

.1 Break material down to sizes suitable for compaction and mix for uniform moisture to full depth of layer.

.2 Deposit, spread, and level, embankment material in layers 200 mm maximum thickness before compaction.

.1 Ensure required compaction for each layer before placing any material for next layer.

.3 Use specialized compaction equipment supplemented by routing, hauling, and leveling equipment over each layer of fill.

.4 Compact each layer to minimum 95% maximum dry density: ASTM D698 except top 150 mm of subgrade.

.1 Compact top 150 mm to 95% maximum dry density, -0, +3% moisture densities from optimum.

.5 Add water or dry as required to bring moisture content of materials to level required to achieve specified compaction.

3.7 FINISHING

.1 Shape entire roadbed to within 25 mm of design elevations.

.2 Finish slopes, ditch bottoms and borrow pits true to lines, grades and drawings where applicable.

.3 Remove rocks over 150 mm in dimension from slopes and ditch bottoms.

.4 Hand finish slopes that cannot be finished satisfactorily by machine.

.5 Round top of backslope 1.5 m both sides of top of slope.

.6 Trim between constructed slopes and edge of clearing to provide drainage and free of humps, sags and ruts.

3.8 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse or recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.9 PROTECTION

.1 Maintain finished surfaces in condition conforming to this section until acceptance by Departmental Representative.

.2 Provide silt fences and erosion protection as required to mitigate and prevent impacts to adjacent properties.

3.10 TESTING

.1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid for by the Contractor.

.2 Density testing of roadway embankments: one test for each 500 square metres for each 150 mm compacted lift.

.3 Density testing of subgrade: one test for each 250 square metres of subgrade.

.4 Moisture densities: -0, +3% from optimum.

.5 Compaction: 95%.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM C117, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.

.2 ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.

.5 ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600kN-m/m^3).

.6 ASTM D1557, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft^3) (2,700kN-m/m^3).

.7 ASTM D1883, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

.8 ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.2, Sieves, Testing, Woven Wire, Metric.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

Part 2 Products

2.1 MATERIALS

.1 Granular sub-base material:

.1 Course well graded pit run sand.

.2 Gradations and properties to Saskatchewan Ministry of Highways and Infrastructure Type 8 granular sub-base.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for granular sub-base installation.

.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 PLACING

.1 Place granular sub-base after subgrade is inspected and approved by Departmental Representative.

.2 Construct granular sub-base to depth and grade in areas indicated.

.3 Ensure no frozen material is placed.

.4 Place material only on clean unfrozen surface, free from snow or ice.

.5 Begin spreading sub-base material on crown line or high side of one-way slope.

.6 Place granular sub-base materials using methods which do not lead to segregation or degradation.

.7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.

.1 Departmental Representative may authorize thicker lifts if specified compaction can be achieved.

.8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.9 Remove and replace portion of layer in which material has become segregated during spreading.

3.4 COMPACTION

.1 Compaction equipment to be capable of obtaining required material densities.

.2 Sub-base course shall be compacted to a minimum of 100% Standard Proctor density. The sub-base course shall be free of any rutting or deformations before placement of the next course.

.3 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.

.4 Apply water as necessary during compaction to obtain specified density.

.5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Departmental Representative.

.6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.5 PROOF ROLLING

.1 For proof rolling use a loaded tandem axle truck.

.2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.

.3 Proof roll at level in sub-base as indicated.

.1 If non-standard proof rolling equipment is approved, Departmental Representative will determine level of proof rolling.

.4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

.5 Where proof rolling reveals areas of defective subgrade:

.1 Remove sub-base and subgrade material to depth and extent as directed by Departmental Representative.

.2 Backfill excavated subgrade with sub-base material and compact in accordance with this section.

.3 Replace sub-base material and compact.

.6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

3.6 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 SITE TOLERANCES

.1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

3.8 PROTECTION

.1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed.

3.9 TESTING

.1 Gradation testing of sub-base material: one test per 500 tonnes of material placed no compaction testing requirement.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM C117, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.

.2 ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.4 ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3).

.5 ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3).

.6 ASTM D1883, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

.7 ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1, Sieves, Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2, Sieves, Testing, Woven Wire, Metric.

.3 U.S. Environmental Protection Agency (EPA) / Office of Water

.1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 DELIVERY, STORAGE AND HANDLING

.1 Storage and Handling Requirements:

.1 Stockpile minimum 50% of total aggregate required prior to beginning operation.

.2 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.3 Replace defective or damaged materials with new.

.2 Develop Construction Waste Management Plan related to Work of this Section.

.3 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan.

Part 2 Products

2.1 MATERIALS

.1 Granular base: material in accordance with the following requirements:

- .1 Well graded crushed stone or gravel.
- .2 Gradations and properties to Saskatchewan Ministry of Highways and Infrastructure Type 33 granular base.
  - .1 Liquid limit: to maximum 25.
  - .2 Plasticity index: to maximum 6.
  - .3 Crushed particles: at least 50% of particles by mass to have at least 1 freshly fractured face.

Part 3 Execution

3.1 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PLACEMENT AND INSTALLATION

.1 Place granular base after sub-base or subgrade surface is inspected and approved by Departmental Representative.

.2 Placing:

- .1 Construct granular base to depth and grade in areas indicated.
- .2 Ensure no frozen material is placed.
- .3 Place material only on clean unfrozen surface, free from snow and ice.
- .4 Begin spreading base material on crown line or on high side of one-way slope.
- .5 Place material using methods which do not lead to segregation or degradation of aggregate.
- .6 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
  - .1 Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.
- .7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.8 Remove and replace that portion of layer in which material becomes segregated during spreading.

.3 Compaction Equipment:

.1 Ensure compaction equipment is capable of obtaining required material densities.

.4 Compacting:

.1 Compact to density not less than 100% Standard Proctor dry density.

.2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.

.3 Apply water as necessary during compacting to obtain specified density.

.4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Departmental Representative.

.5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

.5 Proof rolling:

.1 For proof rolling use loaded tandem axle truck.

.2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.

.3 Proof roll at level in granular base as indicated.

.1 If use of non-standard proof rolling equipment is approved, Departmental Representative to determine level of proof rolling.

.4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

.5 Where proof rolling reveals areas of defective subgrade:

.1 Remove base, sub-base and subgrade material to depth and extent as directed by Departmental Representative.

.2 Backfill excavated subgrade with sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-Base.

.3 Replace sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-base.

.4 Replace base material and compact in accordance with this Section.

.6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Departmental Representative and replace with new materials in accordance with Section 32 11 16.01 - Granular Sub-base and this section at no extra cost.

3.3 SITE TOLERANCES

.1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse or recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

.2 Divert unused granular material from landfill to local facility approved by Departmental Representative.

3.5 PROTECTION

.1 Maintain finished base in condition conforming to this Section until succeeding material is applied.

3.6 TESTING

.1 Gradation testing of base material: one test per 500 tonnes of material placed, test should include fractured faces determination.

.2 Density testing of base: one test for each 250 square metres of surface.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Association of State Highway and Transportation Officials (AASHTO)

.1 AASHTO M081-92-UL, Standard Specification for Cutback Asphalt (Rapid-Curing Type).

.2 ASTM International

.1 ASTM D140/D140M, Standard Practice for Sampling Bituminous Materials.

.2 ASTM D633, Standard Volume Correction Table for Road Tar.

.3 ASTM D1250, Standard Guide for Use of the Petroleum Measurement Tables.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-16.2, Emulsified Asphalts, Anionic Type, for Road Purposes.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

.1 Upon request from Departmental Representative, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect asphalt tack coats from nicks, scratches and blemishes.

.3 Replace defective or damaged materials with new.

.4 Deliver, store and handle materials in accordance with ASTM D140.

.5 Provide, maintain and restore asphalt storage area.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse or recycling.

Part 2 Products

2.1 MATERIALS

.1 Anionic emulsified asphalt: to CAN/CGSB-16.2, grade: SS-1.

.2 Cut-back asphalt; to AASHTO M081-92-UL, grade RC-70 or RC-250.

.3 Water: clean, potable, free from foreign matter.

2.2 EQUIPMENT

.1 Equipment required for Work of this Section to be in satisfactory working condition and maintained for duration of Work.

.2 Pressure distributor:

.1 Designed, equipped, maintained and operated so that asphalt material can be:

.1 Maintained at even temperature.

.2 Applied uniformly on variable widths of surface up to 5 m.

.3 Distribute in uniform spray without atomization at temperature required.

.2 Equipped with meter, registering travel in metres per minute, visibly located to enable truck driver to maintain constant speed required for application at specified rate.

.3 Equipped with pump having flow meter graduated in units of 5 L or less per minute passing through nozzles and readily visible to operator. Pump power unit to be independent of truck power unit.

.4 Equipped with easily read, accurate and sensitive device which registers temperature of liquid in reservoir.

.1 Measure temperature to closest whole number.

.5 Equipped with accurate volume measuring device or calibrated tank.

.6 Equipped with nozzles of same make and dimensions, adjustable for fan width and orientation.

.7 Equipped with nozzle spray bar, with operational height adjustment in increments of 0.6 metres and capable of being raised or lowered.

.8 Cleaned if previously used with incompatible asphalt material.

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 asphalt tack coat installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative .

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 APPLICATION

.1 Apply asphalt tack coat only on clean and dry surface.

.2 Dilute asphalt emulsion with water at 1:1 ratio for application.

.1 Mix thoroughly by pumping or other method approved by Departmental Representative .

.3 Apply asphalt tack coat evenly to pavement surface at approved rate but not to exceed 0.5 L/m^2.

.4 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt tack coat material.

.5 Apply asphalt tack coat only when air temperature greater than 2 degrees C and when rain is not forecast within 2 hours minimum of application.

.6 Apply asphalt tack coat only on unfrozen surface.

.7 Evenly distribute localized excessive deposits of tack coat by brooming as directed by Departmental Representative .

.8 Keep traffic off tacked areas until asphalt tack coat has set.

.9 Re-tack contaminated or disturbed areas as directed by Departmental Representative .

.10 Permit asphalt tack coat to set before placing asphalt pavement.

.11 Inspect tack coat application to ensure uniformity.

.1 Re-spray areas of insufficient or non-uniform tack coat coverage as directed by Departmental Representative .

.2 Ensure tack coating performed using hand held devices is consistent in appearance with adjacent areas of machine applied material.

3.3 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse and recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

.1 ASTM D140/D140M, Standard Practice for Sampling Bituminous Materials.

.2 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-16.1, Cutback Asphalts for Road Purposes.

.2 CAN/CGSB-16.2, Emulsified Asphalts, Anionic Type, for Road Purposes.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

.1 Upon request from Departmental Representative, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials in accordance with manufacturer's written instructions.

.2 Storage and Handling Requirements:

.1 Deliver, store and handle materials to ASTM D140.

.2 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.3 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified.

Part 2 Products

2.1 MATERIAL

.1 Asphalt material: to CAN/CGSB-16.1 grade: RM-20, MC-30, MC-250. CAN/CGSB-16.2 grade: SS-1.

.2 Sand blotter: clean granular material passing 4.75 mm sieve and free from organic matter or other deleterious materials.

.3 Water: clean, potable, free from foreign matter.

2.2 EQUIPMENT

.1 Pressure distributor:

.1 Designed, equipped, maintained and operated so that asphalt material can be:

.1 Maintained at even temperature.

.2 Applied uniformly on variable widths of surface up to 5 m.

.3 Applied at controlled rates from 0.5 to 5.4 L/m^{2}with uniform pressure, and allowable variation from any specified rate not exceeding 0.1 L/m^2.

.4 Distributed in uniform spray without atomization at temperature required.

.2 Equipped with meter registering travel distance in metres per minute, visibly located to enable truck driver to maintain constant speed required for application at specified rate.

.3 Equipped with pump having flow meter graduated in units of 5 L or less per minute passing through nozzles and readily visible to operator.

.1 Pump power unit to be independent of truck power unit.

.4 Equipped with easily read, accurate and sensitive device which registers temperature of liquid in reservoir.

.1 Temperature to be measured to nearest whole number.

.5 Equipped with accurate volume measuring device or calibrated tank.

.6 Equipped with nozzles of same make and dimensions, adjustable for fan width and orientation.

.7 Equipped with nozzle spray bar, with operational height adjustment in increments of 0.6 metres and capable of being raised or lowered.

.8 Cleaned if previously used with incompatible asphalt material.

.2 Aggregate Spreader:

.1 Apply blotter sand to primed surfaces using roll type spreader, or rotating disc sander capable of applying aggregate at variable widths and at variable rates.

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 asphalt prime coat installation in accordance with manufacturer's written instructions.

.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 APPLICATION

.1 Proceed with application of prime coat only after receipt of approval of granular base surface from Departmental Representative.

.2 Cutback asphalt:

.1 Heat asphalt prime as recommended prior to pumping and spraying.

.2 Apply asphalt prime to granular base at rate as directed by Departmental Representative, between 0.5 and 0.8 L/m^2 but not to exceed 2 L/m^2.

.3 Apply on dry surface unless otherwise directed by Departmental Representative.

.3 Anionic emulsified asphalt:

.1 Dilute asphalt emulsion with clean water at 1:1 ratio for application.

.2 Mix thoroughly by pumping or other method approved by Departmental Representative.

.3 Apply diluted asphalt emulsion at rate directed by Departmental Representative, but do not exceed 5 L/m^2.

.4 Apply diluted asphalt emulsion on damp surface unless otherwise directed by Departmental Representative.

.4 Apply asphalt prime only on unfrozen surface.

.5 Apply asphalt tack coat only when air temperature is greater than 10 degrees C and when rain is not forecast within 2 hours minimum of application.

.6 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt prime material.

.7 Where traffic is to be maintained, treat no more than one-half width of surface in one application.

.8 Prevent overlap at junction of applications.

.9 Do not prime surfaces that will be visible when paving is complete.

.10 Apply additional material to areas not sufficiently covered as directed by Departmental Representative.

.11 Keep traffic off primed areas until asphalt prime has cured.

.12 Permit prime to cure before placing asphalt paving.

3.3 USE OF SAND BLOTTER

.1 If asphalt prime fails to penetrate within 24 hours, spread sand blotter material in amounts required to absorb excess material.

.2 Allow sufficient time for excess prime to be absorbed.

.3 Apply second application of sand blotter as required.

.4 Do not roll blotter sand.

.5 Sweep and remove excess blotter material.

3.4 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse or recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Association of State Highway and Transportation Officials (AASHTO)

.1 AASHTO M320, Standard Specification for Performance Graded Asphalt Binder.

.2 AASHTO R29, Standard Specification for Grading or Verifying the Performance Graded of an Asphalt Binder.

.3 AASHTO T245, Standard Method of Test for Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus.

.2 Asphalt Institute (AI)

.1 AI MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.

.3 ASTM International

.1 ASTM C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.

.2 ASTM C117, Standard Test Method for Material Finer Than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.

.3 ASTM C123, Standard Test Method for Lightweight Particles in Aggregate.

.4 ASTM C127, Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.

.5 ASTM C128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.

.6 ASTM C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.7 ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.

.8 ASTM C207, Standard Specification for Hydrated Lime for Masonry Purposes.

.9 ASTM D995, Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.

.10 ASTM D2419, Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

.11 ASTM D3203, Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.

.12 ASTM D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

.4 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1, Sieves Testing, Woven Wire, Inch Series.

.2 CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.

.5 U.S. Environmental Protection Agency (EPA) / Office of Water

.1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 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 asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C 4 weeks prior to beginning Work.

.3 Test and Evaluation Reports:

.1 Submit manufacturer's test data and certification that asphalt cement meets specification requirements.

.2 Submit manufacturer's test data and certification that hydrated lime meets specified requirements.

.3 Submit asphalt concrete mix design and trial mix test results to Departmental Representative for review at least 4 weeks prior to beginning Work.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Deliver and stockpile aggregates in accordance with and erosion and sedimentation control plan. Stockpile minimum 50% of total amount of aggregate required before beginning asphalt mixing operation.

.3 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.

.4 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.

.5 Provide approved storage, heating tanks and pumping facilities for asphalt cement.

Part 2 Products

2.1 MATERIALS

.1 Asphalt Concrete Mix Design and Characteristics to meet Saskatchewan Ministry of Highways and Infrastructure Type 2 or 3.

.2 Performance graded asphalt cement: to 150-200A.

.3 Stability: Minimum 8000 N.

2.2 EQUIPMENT

.1 Pavers: mechanical self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.

.2 Rollers: sufficient number of type and weight to obtain specified density of compacted mix.

.3 Vibratory rollers:

.1 Drum diameter: 1200 mm minimum.

.2 Amplitude of vibration (machine setting): 0.5 mm maximum for lifts less than 40 mm thick.

.4 Haul trucks: sufficient number and of adequate size, speed and condition to ensure orderly and continuous operation and as follows:

.1 Boxes with tight metal bottoms.

.2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.

.3 In cool weather or for long hauls, insulate entire contact area of each truck box.

.4 Use only trucks which can be weighed in single operation on scales supplied.

.5 Hand tools:

.1 Lutes or rakes with covered teeth for spreading and finishing operations.

.2 Tamping irons having mass 12 kg minimum and bearing area not exceeding 310 square metres for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by, may be used instead of tamping irons.

.3 Straight edges, 4.5 m in length, to test finished surface.

2.3 MIX DESIGN

.1 Mix design to be approved in writing by Departmental Representative.

.2 Mix design to be developed by testing laboratory approved in writing by Departmental Representative.

.3 Mix to contain maximum 50% by mass of RAP. Departmental Representative may approve higher proportion of RAP if Contractor demonstrates ability to produce mix meeting requirements of specification.

.4 Design of mix: by Marshall method to Saskatchewan Ministry of Highways and Infrastructure Type 2 or 3 mix design and the requirements below.

.1 Compaction blows on each face of test specimens: 50.

.2 Mix physical requirements:

Property	Roads
Marshall Stability at 60 degrees C kN min	8.0 surface course/8.0 lower course
Flow Value mm	2.0 – 5.0
Air Voids in Mixture, %	3-5 surface course
Voids in Mineral Aggregate, % min	15 surface course
Index of Retained Stability % minimum	70

.3 Measure physical requirements as follows:

.1 Marshall load and flow value: to AASHTO T245.

.2 Compute void properties on basis of bulk specific gravity of aggregate to ASTM C127 and ASTM C128. Make allowance for volume of asphalt absorbed into pores of aggregate.

.3 Air voids: to ASTM D3203.

.4 Voids in mineral aggregates: to AI MS2.

.4 Do not change job-mix without prior approval of Departmental Representative. When change in material source proposed, new job-mix formula to be approved by Departmental Representative.

.5 Return plant dust collected during processing to mix in quantities acceptable to Departmental Representative.

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 asphalt paving in accordance with manufacturer's written instructions.

.1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PLANT AND MIXING REQUIREMENTS

.1 Batch and continuous mixing plants:

.1 To ASTM D995.

.2 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.

.1 Do not load frozen materials into bins.

.3 Feed cold aggregates to plant in proportions to ensure continuous operations.

.4 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.

.5 Before mixing, dry aggregates to moisture content not greater than 1 % by mass or to lesser moisture content if required to meet mix design requirements. Heat to temperature required to meet mixing temperature as directed by Departmental Representative after combining with RAP.

.6 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job-mix requirements.

.7 Store hot screened aggregates in manner to minimize segregation and temperature loss.

.8 Heat asphalt cement and aggregate to mixing temperature directed by Departmental Representative. Do not heat asphalt cement above maximum temperature indicated on temperature-viscosity chart.

.9 Make available current asphalt cement viscosity data at plant. With information relative to viscosity of asphalt being used, Departmental Representative to review temperature of completed mix at plant and at paver after considering hauling and placing conditions.

.10 Maintain temperature of materials within 5 degrees C of specified mix temperature during mixing.

.11 Mixing time:

.1 In batch plants, both dry and wet mixing times as directed by Departmental Representative. Continue wet mixing as long as necessary to obtain thoroughly blended mix but not less than 30s or more than 75s.

.2 In continuous mixing plants, mixing time as directed by Departmental Representative but not less than 45s.

.12 Where RAP is to be incorporated into mix:

.1 Feed from separate cold feed bin specially designed to minimize consolidation of material.

.1 Provide 50 mm scalping screen on cold feed to remove oversized pieces of RAP.

.2 Ensure positive and accurate control of RAP cold feed by use of hydraulic motor or electric clutch and equip with anti rollback device to prevent material from sliding backward on feed belt.

.3 Combine RAP and new aggregates in proportions as specified. Dry mix thoroughly, until uniform temperature within plus or minus 5 degrees C of mix temperature, as directed Departmental Representative, is achieved prior to adding new asphalt cement.

.1 Do not add new asphalt cement where temperature of dried mix material is above 160 degrees C.

.2 Dryer drum mixing plant:

.1 To ASTM D995.

.2 Load aggregates from individual stockpiles to separate cold feed bins. Do not load frozen materials into bins.

.3 Feed aggregates to burner end of dryer drum by means of multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.

.4 Where RAP is to be incorporated into mix, dryer drum mixer is to be designed to prevent direct contact of RAP with burner flame or with exhaust gases hotter than 180 degrees C.

.5 Feed RAP from separate cold feed bin designed to minimize reconsolidation of material.

.6 Meter total flow of aggregate and RAP using electronic weigh belt system with indicator that can be monitored by plant operator and which is interlocked with asphalt pump to ensure proportions of aggregate, RAP and asphalt entering mixer remain constant.

.7 Allow for easy calibration of weighing systems for aggregates and RAP without having material enter mixer.

.8 Calibrate bin gate openings and conveyor speeds to ensure mix proportions are achieved.

.1 Calibrate weigh bridge on charging conveyor by weighing amount of aggregate passing over weigh bridge in set amount of time.

.2 Difference between this value and amount shown by plant computer system to differ by not more than plus or minus 2 %.

.9 Make provision for conveniently sampling full flow of materials from cold feed.

.10 Provide screens or other suitable devices to reject oversize particles or lumps of aggregate and RAP from cold feed prior to entering drum.

.11 Provide system interlock stop on feed components if either asphalt or aggregate from bin stops flowing.

.12 Accomplish heating and mixing of asphalt mix in approved parallel flow dryer-mixer in which aggregate enters drum at burner end and travels parallel to flame and exhaust gas stream.

.1 Control heating to prevent fracture of aggregate or excessive oxidation of asphalt.

.2 Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with printing recorder that can be monitored by plant operator.

.3 Submit printed record of mix temperatures at end of each week.

.13 Ensure mixing period and temperature to produce uniform mixture in which particles are thoroughly coated, and moisture content of material as it leaves mixer is 2 % maximum.

.3 Temporary storage of hot mix:

.1 Provide mix storage of sufficient capacity to permit continuous operation and designed to prevent segregation.

.2 Do not store asphalt mix in storage bins in excess of 3 hour.

.4 Mixing tolerances:

.1 Permissible variation of asphalt cement from job mix: 0.25%.

.2 Permissible variation of mix temperature at discharge from plant: 5 degrees C.

3.3 PREPARATION

.1 Temporary Erosion and Sedimentation Control:

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.2 Apply prime coat and tack coat in accordance with Section 32 12 13.23 - Asphalt Prime Coats and Section 32 12 13.16 - Asphalt Tack Coats prior to paving.

.3 Prior to laying mix, clean surfaces of loose and foreign material.

3.4 TRANSPORTATION OF MIX

.1 Transport mix to job site in vehicles cleaned of foreign material.

.2 Paint or spray truck beds with limewater, soap or detergent solution, or non-petroleum based commercial product, at least daily or as required.

.1 Raise truck bed and thoroughly drain, and ensure no excess solution remains in truck bed.

.3 Schedule delivery of material for placing in daylight, unless Departmental Representative approves artificial light for night placing.

.4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation.

.1 Do not dribble mix into trucks.

.5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.

.6 Deliver loads continuously in covered vehicles and immediately spread and compact.

.1 Deliver and place mixes at temperature within range as directed by Departmental Representative, but not less than 135 degrees C.

3.5 PLACING

.1 Obtain Departmental Representative's approval of base prime coat prior to placing asphalt.

.2 Place asphalt concrete to thicknesses, grades and lines as indicated.

.3 Placing conditions:

.1 Place asphalt mixtures only when air temperature is above 3 degrees C minimum.

.2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.

.3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.

.4 Place asphalt concrete in compacted lifts of thickness as follows:

.1 Levelling courses to thicknesses required but not exceeding 70 mm.

.2 Surface course in layer of maximum 70 mm.

.5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.

.6 Place individual strips no longer than 500 m.

.7 On airport runways and taxiways, aprons and parking lots commence spreading at high side of pavement or at crown and span crowned centerlines with initial strip.

.8 Spread and strike off mixture with self-propelled mechanical finisher.

.1 Construct longitudinal joints and edges true to line markings.

.1 Position and operate paver to follow established line closely.

.2 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver.

.1 Work pavers as close together as possible and in no case permit them to be more than 30 m apart.

.3 Maintain constant head of mix in auger chamber of paver during placing.

.4 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.

.5 Correct irregularities in alignment left by paver by trimming directly behind machine.

.6 Correct irregularities in surface of pavement course directly behind paver.

.1 Remove excess material forming high spots using shovel or lute.

.1 Fill and smooth indented areas with hot mix.

.2 Do not broadcast material over such areas.

.7 Do not throw surplus material on freshly screeded surfaces.

.9 When hand spreading is used:

.1 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section.

.1 Use measuring blocks and intermediate strips to aid in obtaining required cross-section.

.2 Distribute material uniformly without broad casting material.

.3 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes.

.1 Reject material that has formed into lumps and does not break down readily.

.4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.

.5 Provide heating equipment to keep hand tools free from asphalt.

.1 Control temperature to avoid burning material.

.2 Do not use tools at higher temperature than temperature of mix being placed.

3.6 COMPACTING

.1 Roll asphalt continuously to density not less than 98 % of 50 blow Marshall density to AASHTO T245.

.2 General:

.1 Provide at least 2 rollers and as many additional rollers as necessary to achieve specified pavement density. When more than 2 rollers are required, 1 roller must be pneumatic tired type.

.2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.

.3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.

.4 Use static compaction for levelling coarse less than 25 mm thick.

.5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.

.6 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.

.7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.

.8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.

.9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.

.10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.

.1 Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.

.11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.

.12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.

.3 Breakdown rolling:

.1 Begin breakdown rolling with vibratory roller immediately following rolling of transverse and longitudinal joint and edges.

.2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.

.3 Operate breakdown roller with drive roll or wheel nearest finishing machine. When working on steep slopes or super-elevated sections use operation approved by Departmental Representative.

.4 Use only experienced roller operators.

.4 Intermediate rolling:

.1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.

.2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.

.5 Finish rolling:

.1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks.

.1 If necessary to obtain desired surface finish, use pneumatic-tired rollers as directed by Departmental Representative.

.2 Conduct rolling operations in close sequence.

3.7 JOINTS

.1 General:

.1 Remove surplus material from surface of previously laid strip.

.1 Do not deposit on surface of freshly laid strip.

.2 Construct joints between asphalt concrete pavement and Portland cement concrete pavement as indicated.

.3 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.

.2 Transverse joints:

.1 Offset transverse joint in succeeding lifts by at least 600 mm.

.2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.

.3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.

.3 Longitudinal joints:

.1 Offset longitudinal joints in succeeding lifts by at least 150 mm.

.2 Overlap previously laid strip with spreader by 25 to 50 mm.

.3 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.

.4 Roll longitudinal joints directly behind paving operation.

.5 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.

.4 Construct feather joints so that thinner portion of joint contains fine graded material obtained by changed mix design or by raking out coarse aggregate in mix.

.1 Place and compact joint to ensure joint is smooth and without visible breaks in grade.

.2 Locate feather joints as indicated.

.5 Construct butt joints as indicated.

3.8 FINISH TOLERANCES

.1 Finished asphalt surface to be within 5 mm of design elevation but not uniformly high or low.

.2 Finished asphalt surface not to have irregularities exceeding 5 mm when checked with 4.5 m straight edge placed in any direction.

3.9 DEFECTIVE WORK

.1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required.

.1 If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.

.2 Repair areas showing checking, rippling, or segregation.

.3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

.4 The average asphalt concrete thickness must meet or exceed the required thickness and if any individual core thickness is less than the required thickness the following pay reduction shall apply:

THICKNESS DEFICIENCY (mm)	PAY FACTOR (%) NEW CONSTRUCTION	PAY FACTOR (%) REHABILITATION CONSTRUCTION
Up to 3	100	100
3 to 5	98	100
6	95	95
7	90	90
8	80	80
9	70	70
10	50	50
Over 10	Remove and replace	Remove and replace

* The minimum area for pay reductions, including removal and replacement, shall be the full width of the paved lane and a minimum length of 10 lineal meters.

.5 When deviations in excess of the above tolerances are found the pavement surface shall be corrected by methods satisfactory to the Departmental Representative.

.6 The completed pavement shall have an average density of ninety-eight percent (98%) and in no case shall any individual density test be less than ninety-six percent (96%) If the laboratory compacted density as determined by ASTM Designation D1559 or AASHTO T245, Resistance to Plastic Flow of Bituminous Mixture Using Marshall Apparatus, using a compaction of fifty blows for each face. The intent is that a long term durable product be provided. The following table represents payment reduction based on average density of cores not meeting minimum values.

COMPACTED DENSITY % OF MARSHALL	PAY FACTOR %
98 to 100	100
97.6 to 97.9	98
97.0 to 97.5	96
96.6 to 96.9	93
96.0 to 96.5	90
94.0 to 95.9	75
92.0 to 93.9	50
Less than 92%	Remove and replace

If a core density on any individual test is les than 96%, a pay reduction of 90% will be applied to a minimum area of 100 m^2.

3.10 CLEANING

.1 Progress Cleaning:

.1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

.3 Waste Management: separate waste materials for reuse or recycling.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.11 TESTING

.1 Marshall Extraction and Sieve of Asphalt: one test for each 400 tonnes of asphalt minimum one per day.

.2 Nuclear density testing of asphalt: one test per 250 square metres of asphalt.

.3 Corning of finished asphalt for thickness and one density text for each 500 square metres of surface.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 11 16.01 Granular Sub-base.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

- .1 ASTM C117, Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
- .2 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .3 ASTM D260, Standard Specification for Boiled Linseed Oil.
- .4 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600 kN-m/m^3).

.2 Canadian General Standards Board (CGSB)

- .1 CAN/CGSB-3.3, Kerosene, Amend. No. 1, National Standard of Canada.
- .2 CAN/CGSB-8.1, Sieves, Testing, Woven Wire, Inch Series.

.3 Canadian Standards Association (CSA International)

- .1 CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit concrete mix design for concrete curbs 4 weeks prior to start of construction.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

- .1 Separate waste materials for reuse and recycling.

Part 2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with Section 03 30 00.01 - Cast-in-Place Concrete – Short Form.

.2 Table: Class of Concrete:

Class	Location	(MPa)	Cement Type	Aggregate Max. (mm)	Slump (mm)	Total Air Content (%)
A	Extruded Curb	32	GU	20	30±10	6±1
B	Handed-formed C&G	32	GU	20	75±20	6±1

.3 Reinforcing steel: in accordance with Section 03 30 00.01 - Cast-in-Place Concrete – Short Form

.4 Joint filler and Curing Compound: in accordance with Section 03 30 00.01 - Cast-in-Place Concrete – Short Form

.5 Granular base: material to Section 32 11 16.01 Granular Sub-base.

.6 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water-soluble soap.

.7 Fill material: to Section 32 11 16.01 Granular Sub-base.

Part 3 Execution

3.1 GRADE PREPARATION

.1 Do grade preparation work in accordance with Section 31 24 13 Roadway Embankments.

.2 Construct embankments using excavated material free from organic matter or other objectionable materials.

.1 Dispose of surplus and unsuitable excavated off site.

.3 When constructing embankment provide for minimum 1 m shoulders, where applicable, outside of neat lines of concrete.

.4 Place fill in maximum 150 mm layers and compact to at least 95% of maximum dry density to ASTM D698.

3.2 GRANULAR BASE

.1 Obtain Consultant's approval of subgrade before placing granular base.

.2 Place granular base material to lines, widths, and depths as indicated.

.3 Compact granular base in maximum 150 mm layers to at least 100% of maximum density to ASTM D698.

3.3 CONCRETE

.1 Obtain Consultant's approval of granular base and reinforcing steel prior to placing concrete.

.2 Do concrete work in accordance with Section 03 30 00.01 - Cast-in-Place Concrete – Short Form.

.3 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom in direction normal to centre line.

.4 Provide edging as indicated with 10 mm radius edging tool.

.5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to Consultant can be demonstrated. Hand finish surfaces when directed by Consultant.

3.4 TOLERANCES

.1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.5 EXPANSION AND CONTRACTION JOINTS

.1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 1.5 m.

.2 Install expansion joints at intervals of 3 m.

.3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.6 CURING

.1 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.7 BACKFILL

.1 Allow concrete to cure for 7 days prior to backfilling.

.2 Backfill to designated elevations with material as directed by Consultant.

.1 Compact and shape to required contours as indicated.

3.8 CLEANING

.1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

3.9 TESTING

.1 Concrete testing sidewalks and curbs: one complete test as defined by the CSA for each 20 cubic metres or portion thereof per day per class, supplier of concrete or per separate pore.

END OF SECTION

PART 1 General

1.1 SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and data sheet 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.

.2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

1.2 DELIVERY, STORAGE, AND HANDLING

.1 Packing, Shipping, Handling and Unloading:

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

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials 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 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.

PART 2 Products

2.1 PRODUCTS

.1 Fence Fabric: 50 mm mesh by 9 gauge, zinc coated after weaving. Minimum zinc coating to be 490 grams per square metre of surface area. Twist or barb selvage edges. Fabric height shall be 2,440 mm unless otherwise indicated.

.2 Terminal, Corner and Straining Posts: The terminal posts and straining posts shall be 90 mm O.D. with minimum weight of 11.24 kg per metre, Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. The minimum length of terminal posts and straining posts shall be 4000mm

.3 Line Posts: Posts shall be 60 mm O.D. with minimum weight of 5.43 kg per metre, Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre. The minimum length of line posts shall be 2440 mm unless otherwise indicated.

.4 Top and Bottom Rails and Pipe Braces: The top rails and pipe braces shall be 43 mm O.D., Schedule 40 pipe, zinc coated with minimum coating of 490 grams per square metre.

.5 Top and Bottom Wire: Wire shall be Number 6 Gauge, single strand 57 grams electro-galvanized and be stretched taut along the top and bottom of the fabric fastened at 460 mm intervals

.6 Accessories: other components such as tension bars, bands, rail ends, terminal post tops, line post tops, top rail sleeves, wire ties, nuts, bolts, and washers to be zinc coated steel with a minimum coating of 490 grams per square meter.

PART 3 Execution

3.1 INTERIOR INSTALLATION

.1 Provide chainlink fencing as noted in drawings.

.2 Provide terminal posts and straining posts in accordance with manufacturer’s written instructions and as noted in drawings.

.3 Install post floor retainers, mechanically fasten to concrete floor.

.4 Install terminal posts and straining posts plumb and in accordance with drawings.

.5 Straining posts shall be installed as per the manufacturer's instructions.

.6 Brace terminal sections, straining sections and corner sections with a pipe brace as per the manufacturer's instructions and the drawings.

.7 Attach fence fabric, wire ties, top rail, pipe braces, tension bar and fittings to the posts and assembled according to the manufacturer's instructions and as specified on the drawings.

.8 Provide post at each side of door frame, typical for each frame.

.9 Tack weld door frame to support posts. Refer to Section 08 11 00 Metal Doors and Frames.

3.2 EXTERIOR INSTALLATION

.1 Remove existing chainlink fence as noted in drawings and salvage fencing components for installation in new location.

.2 Provide terminal posts and straining posts in accordance with manufacturer’s written instructions and as noted in drawings.

.3 Install terminal posts and straining posts plumb and in accordance with drawings.

.4 Straining posts shall be installed as per the manufacturer's instructions.

.5 Brace terminal sections, straining sections and corner sections with a pipe brace as per the manufacturer's instructions and the drawings.

.6 Attach fence fabric, wire ties, top rail, pipe braces, tension bar and fittings to the posts and assembled according to the manufacturer's instructions and as specified on the drawings.

.7 Provide post at each side of door frame, typical for each frame.

.8 Tack weld door frame to support posts. Refer to Section 08 11 00 Metal Doors and

3.3 CLEANING

.1 Perform cleaning after installation to remove construction and accumulated environmental dirt.

.2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Site furnishing.

1.2 SHOP DRAWINGS AND PRODUCT DATA

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

.2 Indicate dimensions, sizes, assembly and installation details for each furnishing specified.

1.3 LAYING OUT WORK

.1 Lay out work and be responsible for accuracy. Provide the necessary personnel to assist the Departmental Representative in checking the work.

Part 2 Products

2.1 BENCH

.1 Company: Canaan Inc., 140 Bentley Street #3, Markham, ON, L3R 3L2; ph.: 877-305-6638; www.canaaninc.ca

.2 Product: Bench CB-801, powder coated steel frame, colour: black; recycled plastic slats, colour: cedar; dimension: 1800x590x850, surface mounted; 2 required.

.3 Equivalent product will be considered. Contractor to submit a request prior Tender close.

2.2 PICNIC TABLE

.1 Company: Canaan Inc., 140 Bentley Street #3, Markham, ON, L3R 3L2; ph.: 877-305-6638; www.canaaninc.ca

.2 Product: Picnic table CT-030, powder coated steel frame, colour: black; recycled plastic slats, colour: cedar; dimensions: 1830x1637x760, surface mounted; 2 required.

.3 Equivalent product will be considered. Contractor to submit a request prior Tender close.

2.3 RECYCLE/TRASH UNIT

.1 Company: Waste Wise Product Inc., 689 Warden Ave #14, Toronto, ON, M1L 4N5, ph.: 416-686-6816; www.wastewiseproductsinc.com

.2 Product: Recycle/Trash Unit TXZ36-2; two stations, front service, capacity: 36 gal. (to match existing on site); colour: warm cedar; dimensions: 1320x680x485, surface mounted; 2 required.

.3 Equivalent product will be considered. Contractor to submit a request prior Tender close.

2.4 ASH RECEPTACLE

.1 Company: Canaan Inc., 140 Bentley Street #3, Markham, ON, L3R 3L2; ph.: 877-305-6638; www.canaaninc.ca

.2 Product: Wall Mounted Smoking Receptacle CAM-204, solid seamless matte aluminium; colour: matte silver; dimensions: 79 diam. x 483mm, wedge anchor mount; 1 required.

.3 Equivalent product will be considered. Contractor to submit a request prior Tender close.

2.5 BIKE RACK

.1 Company: Canaan Inc., 140 Bentley Street #3, Markham, ON, L3R 3L2; ph.: 877-305-6638; www.canaaninc.ca

.2 Product: Wave Bike Rack CAH-715-B, steel tubing, powder coated finish; colour: black; dimensions: 2360 x 904mm (L x H), accommodates 7 bikes; 2 required.

.3 Equivalent product will be considered. Contractor to submit a request prior Tender close.

Part 3 Execution

3.1 INSTALLATION

.1 Assemble furnishings in accordance with manufacturer's instructions.

.2 Install furnishings, true and plumb to line and level, and firmly fastened, as per manufacturer’s instructions.

.3 All anchor systems shall be in accordance with manufacturer’s instructions specific to each furnishing type.

.4 Touch-up damaged finishes to approval of the Departmental Representative.

.5 Cut attachment bolts flush to nut.

.6 Paint all attachment nuts and bolts to match furniture colour

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Landscape irrigation system.

1.2 LAYING OUT WORK AND INSPECTIONS

.1 Lay out work and be responsible for accuracy. Provide the necessary personnel to assist the Departmental Representative in checking the work.

.2 Coordinate with other contractors working on-site. In particular, ensure coordination with contractors undertaking landscape development, roadways, walkways, underground services and other work directly affected by, or which will have an affect on, irrigation installation.

.3 The Departmental Representative will not be responsible for coordinating work of the various contractors working on site.

.4 Stake locations of heads and valves and review with the Departmental Representative prior to excavation and installation.

.5 Do not allow, nor cause, work to be covered or enclosed until it has been inspected, tested, and approved by the Departmental Representative. Should work be enclosed or covered before such inspection, uncover work at Contractor expense; after inspection and approval make all repairs with equal materials necessary to restore work, and that of other Contractors, to original condition.

1.3 TESTING AND ADJUSTING

.1 Upon completion of the installation, the entire system shall be tested. Air shall be flushed from the pipes and all components shall be checked for proper operation. The system shall not be accepted by the Departmental Representative until all portions are operating as intended and until all deficiencies have been corrected.

.2 Balance and adjust the various components of the irrigation system so that the overall operation is efficient and coverage is uniform.

1.4 AS-BUILT PLAN / MAINTENANCE MANUALS

.1 Upon completion of the work, provide the Departmental Representative with an as-built plan showing the exact location of all components of the system, and four (4) copies of a manual outlining system operation, procedures and maintenance instructions.

.2 The maintenance manuals shall include product information, controller operation and programming instructions, servicing and replacement procedures for all sprinklers and valves, and procedures for blowing out the system in the fall and charging the system in the spring.

1.5 MAINTENANCE (BEFORE WARRANTY PERIOD)

.1 Be responsible for all aspects of system maintenance from completion of installation to date of Substantial Performance of the Work.

.2 System maintenance shall include, but not necessarily be limited to, servicing, repair and replacement of system components as required for efficient operation and uniform coverage.

1.6 MAINTENANCE (DURING WARRANTY PERIOD)

.1 Test and adjust all equipment for smooth trouble-free operation of the irrigation system at the start of the warranty period.

.2 Defects or misalignment of any part of the work caused by settlement of bedding or backfill material within the warranty period shall be corrected at Contractor expense.

.3 Emergency repairs may be required to protect property or permit operation of the work. The Owner shall notify the Contractor immediately, who shall make all necessary repairs. The cost of such emergency repairs shall be paid by the Contractor. Maintenance not of an emergency nature shall be brought to the attention of the Contractor, in writing, who shall take the necessary action to correct the faulty work.

.4 Blow-out all irrigation water lines prior to freeze-up in the fall (October) of the year of completion of the maintenance contract, and reconnect the irrigation system in the spring of the following year.

.5 Notify the Owner and Landscape Contractor two (2) weeks prior to blowing out the system to allow the proper watering-in of plant material prior to fall freeze up.

.6 At the end of the maintenance period, provide on-site orientation to familiarize the maintenance personnel with the operation of the irrigation system and locations of control equipment.

1.7 WARRANTY

.1 All irrigation system equipment and installation shall be warranted for one full year following the date of Substantial Performance of the Work. Exempted is equipment and installation damaged, after date of Substantial Performance of the Work, by accidental causes or vandalism.

.2 End of warranty inspection will be conducted.

Part 2 Products

2.1 PIPE

.1 Underground mainline irrigation pipe from existing mainline to electric valves: high density minimum Series 100 polyethylene (P.E.) pipe conforming to current ASTM F-714.

.2 Underground lateral irrigation line: low density minimum Series 75 polyethylene (P.E.) pipe conforming to current CSA B137.0 and CSA B137.1.

2.2 FITTINGS AND CONNECTORS

.1 Pipe fittings: Rainbird brass saddles with stainless steel bolts; schedule 80 PVC Type I elbows, tees, coupling, bushings, plugs and unions conforming to ASTM D-2464.

2.3 SPRINKLERS AND NOZZLE

.1 Rotors: Rainbird 5004 PRS Series, with MPR and standard angle nozzles; sizes as noted, or approved equivalent.

2.4 LOW FLOW IRRIGATION

.1 Landscape Dripline: Rainbird XFD-09-12 Series or approved equivalent.

.2 Micro Spray: Rainbird Xeri-Pop Micro Spray; XP-600X or approved equivalent. 5ft MPR nozzle set at half circle pattern.

.3 Distribution Tubing: Rainbird XQ ¼” Distribution Tubing or approved equivalent.

.4 Fitting: Rainbird ¼” Barb Tee or approved equivalent.

2.5 QUICK COUPLING VALVES

.1 Rainbird #3 RC, or approved equivalent.

2.6 MANUAL VALVES

.1 Ball valves - 50 mm and smaller use bronze body, screwed ends, full port, 1380 kPa W.O.G. with chromium plated bronze ball and teflon seat. Use Newman Hatterly 1969F Kitz #58, Crane #9322 or TOYO 5044A.

2.7 VALVE BOXES

.1 For automatic and manual valves, and quick couplers: approved fibreglass reinforced plastic boxes complete with bolt down cover; Carson or approved equal.

.2 Granular backfill: 19 mm diameter crushed stone, washed.

2.8 SLEEVES

.1 Install sleeves at locations where lines and/or wires pass under walks and roads.

.2 Sleeves shall extend a minimum of 300mm beyond edge of surfaces.

.3 Sleeves to be 2 dimensional sizes larger than pipe diameter to allow clear passage of all water lines.

.4 Sleeves in areas subject to pedestrian traffic shall conform to the following:

.1 PVC: SDR-35, SDR-28

.2 Polyethylene: 50 mm and under, to CSA B137.1 Series 75

.3 ABS: DB-2, or approved equal.

.4 Pipe sleeves shall be one continuous length.

.5 Sleeves in areas subject to vehicular traffic to be C-900 PVC Class 305, D-14.

2.9 CONTROL LINES

.1 CSA approved, 14 gauge direct burial UF-UL listed TWU-40 wire with the common wire white and the tracer wire green. All other wires can be any colour except white or green.

2.10 ZONE CONTROL VALVES

.1 Rainbird PGA Pressure Regulated Series or approved equivalent; sizes to match incoming line size.

.2 All automatic electric valves shall have plastic or brass ID tags labelled clearly to match numbers at controller.

2.11 CONTROLLER (N.I.C.)

.1 Rainbird ESP-LXME/F series, wall mounted with lockable case, or approved equivalent.

Part 3 Execution

3.1 EXCAVATION

.1 Excavation shall be unclassified and shall include all materials encountered except material which cannot be excavated by normal chain trenching methods. Such exceptions shall be brought to the attention of the Departmental Representative and an adjustment in price shall be agreed upon before excavation of these areas proceeds. Such price adjustments and

agreements shall include responsibility for disposal of the unsuitable materials removed from the trench and the acquiring of additional backfill material.

.2 Depth of cover: minimum 300 mm except where structural requirements and underground service lines interfere. These areas shall have a maximum allowable depth of cover.

.3 Backfill material shall be free from rocks, large stones, and other unsuitable materials which could damage the pipe or create unusual settling problems. Backfilling shall be in maximum 150 mm layers and tamped after each layer to prevent excessive settling.

.4 Avoid damage to any and all existing trees and shrubs including those planted concurrent with the irrigation installation. Where possible, place lines outside the drip line of existing trees. Hand trench around existing trees to avoid damage to root systems. Review conflicts with Departmental Representative.

.5 Avoid damage to any and all underground utilities and structures. Notify utility companies including the power, gas and telephone and have locations staked prior to commencing excavations.

3.2 INSTALLATION OF PIPES AND SLEEVES

.1 Installation of pipes and fittings shall be in accordance with the manufacturer's instructions and shall proceed from the point of connection to supply. Pipes shall be secured to prevent excessive movement from water pressures. Double clamp all connections on continuously pressurized lines.

.2 Sprinkler connections to pipe: approved brass saddle fitting. See detail.

.3 Polyethylene pipe may be installed by standard trenching techniques or by pulling in pipe. If the pull-in method is used, the pipe plow shall be a vibratory type. The mole or bullet, which precedes the pipe and is used to form the opening for the pipe, shall not be less than 25 mm larger in diameter than the outside diameter of the pipe. Hand dig trenches where lines are close to existing structures.

.4 Install sleeves with the top of the pipe 300 to 400 mm below finished grade. Extend sleeves 300 mm beyond hard surfaces and mark locations on the edges of walks and curbs with Tapcon screws or other approved method. Verify with Departmental Representative.

3.3 SPRINKLERS

.1 Pop-up sprinklers in turf areas shall be installed with top slightly above finished grade, level and marked to prevent damage by other equipment during construction. Where heads are adjacent to walks and curbs, install heads 12 mm below top surface of concrete.

.2 All threaded connections shall be wrapped with two layers of teflon tape.

.3 Backfill around the swing joint and sprinkler heads shall be free of rocks larger than 12 mm diameter, roots, debris, and other extraneous matter.

3.4 LANDSCAPE DRIPLINE

.1 Dripline to be installed per manufacturer’s instruction under mulch layer. Secure dripline with required pins.

.2 Install lines adjacent to base of every plant. Ensure line is not kinked so water flows freely.

.3 Install Micro Spray in two locations noted with tee and distribution tubing; spray is intended to be a visible indicator of drip zone operation; ensure location of spray head is

visible from roadway and sidewalk at south end of parking lot, and view is not blocked by plant material or mulch. Adjust spray throw to minimize overthrow onto roadway / sidewalk. Ensure distribution line is secured.

.4 When finished, ensure lines are sufficiently covered with mulch.

3.5 MANUAL AND AUTOMATIC VALVES

.1 Install valves at the location shown on the plan, according to manufacturer's instructions, in a valve box set plumb and flush with the surface. Provide 75 mm depth granular backfill at base.

.2 Label all electric valves with weather resistant tags attached to the handles indicating valve number and controller.

3.6 CONTROL WIRES

.1 Control wires shall be installed in a neat and orderly fashion and may be installed in the pipe trenches or in separate trenches. The wires shall be bundled together and taped every 1.5 m.

.2 Splicing shall be minimized. Where required, splices shall be made waterproof with the use of waterproof splice connection kits.

.3 All 24 volt wiring shall be installed in accordance with existing codes.

.4 Route wires to west side of building to location of new electrical services. Coordinate location with electrical work.

.5 Install wires in steel conduit from below grade to building penetration. Make penetration water/weather tight.

.6 Install wires, within building, in conduit attached to underside of floor slab. Coordinate location with other infrastructure. Label conduit at each with self-adhesive pipe marker labels.

3.7 CONTROLLER

.1 Install wires to existing controller on east side of building. Coordinate new zone run times and length with existing. Indicate new zone operation on controller cabinet schedule and in maintenance manual.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Topsoil, planting mix, fertilizer and finish grading.

1.2 SOIL TESTS

.1 Conduct soil tests of topsoil and planting mix as required to determine recommended soil amendments and fertilizer compositions for seeding and planting. Samples shall be taken in accordance with recommendations of ALS Laboratory Group, 819 58th Street East, 306-668-8370, Saskatoon, SK. Testing regimen as follows:

.1 PSA-2 (Particle size analysis)

.2 C-TOT-ORG (Total organic carbon)

.3 SAL-DETAIL+TGR (detailed salinity)

.2 Soil Analysis Package 1 (For NPKS – with recommendations)

.3 Soil tests shall be paid for by the Contractor and shall be conducted by an approved testing laboratory.

.4 Submit two (2) copies of soil test results and fertilizer recommendations to the Departmental Representative for review.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 Materials

.1 Topsoil: stockpiled and imported material shall be free from subsoil, roots, grass, weeds, toxic materials, stones and foreign objects, and shall be subject to analysis by a testing laboratory before use. Topsoil shall consist of black topsoil, a fertile, friable natural loam, neither heavy clay nor very light sand, consisting of not less than 4% organic matter for clay loams and not less than 2% for sandy loams, with an acidity value ranging from pH 6.0 to 8.0. Amend as recommended by soil tests. Topsoil to be screened and in a moist, not wet, condition when incorporated into the work. Submit a one (1) litre sample to Departmental Representative for approval prior to incorporation into the work.

.2 Manure: well decomposed cattle excrement, rich in organic matter and humus containing balanced proportions of nitrogen, phosphorus and potash; sterilized and free of living vegetation, weed seeds, and couch grass or brome grass rhizomes; in a pulverised, friable condition, not containing fresh or “green” manure, clay, silt, gravel or foreign material.

.3 Compost: well decomposed, stable, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; biosolids (treated sewage sludge); yard trimmings; source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived.

.4 Sand: homogeneous, sharp-grained, 0.5 – 1.5 mm; to approved sample

.5 Planting mix: 60% topsoil, 20% manure or compost, 20% sand; to approved sample.

.6 Fertilizer: Complete commercial synthetic slow release fertilizer with maximum 35% water soluble nitrogen; uniform in composition and free flowing. Formulation ratio: as recommended by soil tests.

Part 3 Execution

3.1 COORDINATION

.1 Ensure proper scheduling of work to avoid conflicts with completed and intended work.

3.2 PREPARATION

.1 Eliminate uneven areas and low spots from areas that have been rough graded. Ensure positive drainage in accordance with grading plans. Notify Departmental Representative of grading problems before proceeding. Remove debris, roots, tree shoots, branches, stones in excess of 50 mm diameter and other extraneous materials. Remove subsoil that has been contaminated with oil, gasoline, calcium chloride or other undesirable chemicals. Dispose of removed materials off site on a daily basis and at a location approved by local officials.

.2 Cultivate all areas, which are to receive planting mix and topsoil to depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted the subgrade.

.3 Do not damage structures, trees, or other materials adjacent to landscaped areas.

3.3 PLANTING MIX

.1 Do not spread planting mix or topsoil until Departmental Representative has inspected subgrade.

.2 Spread planting mix with adequate moisture in uniform layers during dry weather over approved, dry, unfrozen subgrade, where in raised planters and plaza beds as indicated.

.3 Bring planting mix to finish grade

.4 Uniformly place planting mix as indicated in maximum 150 mm loose lifts to the following minimum compacted depths:

.1 150 mm topsoil for seeded and sodded areas.

.2 450 mm planting mix for planting beds.

.5 Compact each lift to minimum 90% Standard Proctor Density.

3.4 FERTILIZER

.1 Apply fertilizer at least 6 days before seeding or planting.

.2 Spread fertilizer uniformly with mechanical spreaders at rate determined on basis of soil tests.

.3 Incorporate fertilizer thoroughly into upper 50 mm of growing media.

3.5 FINISH GRADING

.1 Remove stones, roots, grass, debris and foreign non organic objects from growing media.

.2 Manually spread material in planting beds and turf areas.

.3 Fine grade entire landscaped area. Eliminate rough spots and low areas to ensure positive drainage. Notify Departmental Representative of grading problems before proceeding.

.4 Leave surface smooth and uniform, with a fine loose texture.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Seed and application of seed.

1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Grass seed: Certified Canada No. 1 Grade to Government of Canada Seeds Regulations and having minimum germination of 75% and minimum purity of 97%.

2.2 SEED MIX (by weight)

30% Canada blue var. Reubens or Canon
30% Creeping red fescue (Festuca. rubra) Var: Aberdeen, Jasper 2,
20% Hard fescue (Festuca duriscul) Var. Spartan, Aurora
15% Nakiska sheeps fescue (Festuca ovina)30%
5% Annual Rye, Oats or Barley
Seed at a rate of 2.2 kg/100 m2

Part 3 Execution

3.1 SEEDING

.1 Provide seed mix tag to Departmental Representative for review prior to start of seeding preparation.

.2 Areas to be seeded shall be harrowed once with a landscape harrow to a maximum depth of 50 mm.

.3 Fertilize: Section 32 91 21

.4 Seed shall be evenly applied with an approved mechanical seeder. Seeding shall be done in two operations at right angles to one another. Ensure newly seeded areas blend into existing turf with no noticeable gaps or breaks. Seed to extent of disturbance.

.5 Sow during calm weather (winds less than 10 km/h), using equipment suitable for area involved. Sow half of required amount of seed in one direction and remainder at right angles. Incorporate seed into soil to a maximum depth of 13 mm simultaneously or within one hour after seeding operation. Mix carefully with light chain harrow or wire rakes.

.6 Water with fine spray, avoiding washing out of seed. Apply enough water to ensure penetration of minimum 50 mm.

.7 Protect seeded areas against damage. Maintain protection until acceptance of seeded areas.

.8 Reseed at 2 week intervals where germination has failed.

3.2 ESTABLISHMENT

.1 Keep soil moist during germination period and adequately water seeded areas until accepted by Departmental Representative.

.2 Apply water to ensure moisture penetration of 50 to 100 mm. Control watering to prevent wash-outs.

.3 Cut grass when it reaches height of 75mm, and cut to a height of 50mm. Evenly distribute (do not remove) clippings which exceed 10 mm in depth.

.4 Maintain grassed areas free of weeds and disease.

3.3 ACCEPTANCE

.1 Seeded areas will be accepted provided that:

.1 Seeded areas are properly established and true to grade.

.2 Turf is free of eroded, bare, or dead spots and 90 - 95% free of weeds.

.3 No surface soil is visible when grass has been cut to height of 65 mm.

.4 Seeded areas have been cut at least twice, the last cut being carried out within 24 hours of acceptance.

.2 Areas seeded in fall will be accepted in the following spring one month after start of growing season provided acceptance conditions are fulfilled.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Supply and installation of sod.

Part 2 Products

2.1 MATERIALS

1. Sod: Grade No. 1 cultured turf in accordance with the current edition of the "Metric Guide Specification for Nursery Stock" of the Canadian Nursery Landscape Association (CNLA), composed of a minimum of 60% Kentucky Bluegrass / Poa pratensis. Turf shall be reasonably free from weeds and disease and the thickness of the soil portion of the sod shall be of such density that no surface soil is visible when mowed to a height of 40 mm. The thickness of the soil portion of the sod shall be 20 - 25 mm. All sod shall be mowed to a height of 40 mm prior to cutting and delivery; sod grass shall not be longer than 50 mm upon delivery.

Part 3 Execution

3.1 LAYING OF SOD

1. Immediately, or as soon as possible after delivery to the site, lay the sod. Do not allow to dry before laying. Lay sod evenly and closely packed together, using an alternate pattern. Roll and pack entire sodded area to form an even surface. Complete sodded areas including patching, watering and rolling within 48 hours of laying.
2. Edge sod to form neat 1000 mm diameter circular openings at the base of all trees. Place a full row of sod, not less than 300 mm in width, along the perimeter of sodded areas adjacent to the edges of shrub beds, walks, curbs and walls.
3. Thoroughly water sodded areas within 24 hours of laying sod. After watering, roll edges to form an even surface and to adjoin level with existing grades, and +/- 20 mm below adjacent walks and curbs.
4. Do not lay sod when in a frozen state or in weather conditions unfavourable for transplanting or for growth.

3.2 ACCEPTANCE

1. Sodded areas will be accepted provided that:
   - .1 Sodded areas are properly established and true to grade.
   - .2 Sod is free of bare and dead spots and without weeds.
   - .3 No surface soil is visible when grass has been cut to height of 50 mm.
   - .4 Sodded areas have been cut at least twice, the last cut being carried out within 24 hours of acceptance.
2. Areas sodded in fall, after the normal growing period, will be accepted in the following spring one month after start of growing season provided acceptance conditions are fulfilled.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Supply and installation of plant material.

1.2 SOURCE QUALITY CONTROL

.1 The nursery source shall be located in a hardiness zone 3a or hardier. Contractor to notify Departmental Representative of source of material at least 7 days in advance of shipment.

.2 No work under this Section is to proceed without written approval of plant material at source.

.3 Imported plant material must be accompanied with necessary permits and import licenses. Contractor to conform to all federal, provincial and municipal regulations.

.4 Roses shall be sourced from areas free of the pathogen *Phytophthora ramorum*.

1.3 SHIPMENT AND PRE-PLANTING CARE

.1 Contractor to coordinate shipping of plants and excavation of holes to ensure minimum time lapse between digging and planting.

.2 Contractors to tie branches of trees and shrubs securely and protect plant material against abrasion, exposure and extreme temperature change during transit. Avoid binding of planting stock with rope or wire which would damage bark, break branches or destroy natural shape of plant. Give full support to root ball of large trees during lifting.

.3 Cover plant foliage with tarpaulin, and protect bare roots by means of dampened straw, peat moss, saw dust or other acceptable material to prevent loss of moisture during transit and storage.

.4 Contractor to be responsible for removing/circling/girdling roots by pruning or roughing up root balls where necessary. Planted trees and shrubs found to have circling/girdling roots will be rejected and will require replacement.

.5 Remove broken and damaged roots with sharp pruning shears. Make clean cut and cover cuts over 10 mm diameter with wound dressing.

.6 Keep roots moist and protected from sun and wind. Heel-in trees and shrubs, which cannot be planted immediately, in shaded areas and water well.

1.4 SUBSTITUTIONS

.1 Species and/or size substitutions of plant material may be required by the Landscape Contractor for availability and/or horticultural reasons.

.2 Substitutions must be approved in advance of bid closing in accordance with the bidding process. No substitutions will be considered after bid closing date except under extraordinary circumstances.

1.5 LAYING OUT WORK

.1 Lay out work and be responsible for accuracy. Provide the necessary personnel to assist the Departmental Representative in checking the proposed plant locations.

1.6 GUARANTEE

.1 The Contractor shall agree to guarantee to replace and replant any plant material found dead or in poor condition within one year past the date of substantial completion, without cost to the Owner. “Poor condition” shall be interpreted as meaning plant material on which the

branches are dead or dying, or have not shown satisfactory growth of leaves in the judgement of the Departmental Representative.

.2 The Contractor shall not be held responsible for plant material destroyed by vandalism, after substantial performance is achieved.

.3 Required replacements shall be made promptly and replacements of all unsatisfactory trees and shrubs continue, with all costs borne by the contractor, until the original numbers planted are satisfactory and complete.

.4 The Departmental Representative reserves the right to extend Contractor's warranty responsibilities for an additional one year if, at the end of the initial warranty period, leaf development and growth is not sufficient to indicate future survival.

1.7 REPLACEMENTS

.1 During warranty period, promptly remove from site any plant material that has died or failed to grow satisfactorily as determined by the Departmental Representative.

.2 Replace plant material in the next planting season.

.3 Extend warranty on replacement plant material for a period equal to the original warranty period.

.4 Continue such replacement and warranty until plant material is acceptable.

.5 Flag replaced plant material securely with surveyors flagging.

1.8 CONTRACTOR QUALIFICATIONS

.1 Contractors supplying and/or installing plant material are required, at the discretion of the Departmental Representative, to be Members in-good-standing of the Saskatchewan or Canadian Nursery Landscape Association. Upon request, provide evidence of such standing to the satisfaction of the Departmental Representative.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

.1 Water: potable and free of minerals which may be detrimental to plant growth.

.2 Stakes: T-bar steel stakes 40 x 40 x 5 x 2440 mm or wood 30 x 38 x 2400 mm and as noted on deciduous tree planting detail.

.3 Rails & post – Pressure treated wood; 75-100 diam. x 2000 long posts; 38 x 140 rails.

.4 Cables and accessories: factory galvanized cables, wire tighteners, eyebolts and turnbuckles. Use turnbuckles with 150 mm long eyebolts and 10 mm diameter threaded opening for tightening. Use approved horticultural guy wire tightener as shown on details.

.5 Guy wires: steel wire stand to CSA G4-M1977 at following sizes.

.1 Shrubs and trees under 75 mm calliper use 2.5 mm wire.

.2 Trees 75 to 150 mm calliper use 3 mm wire.

.3 Trees 150 to 500 mm calliper use 3 strands of 4 mm wire twisted together or Grade 110, 8 mm 7 strand cable.

.4 Trees 500 to 750 mm calliper use Grade 110, 10 mm 7 strand cable.

.5 Trees over 750 mm calliper use Grade 160, 10 mm 7 strand cable.

.6 Eyebolts: coarse threaded galvanized steel at following sizes:

.1 Trees 150 – 500 mm calliper use 10 mm diameter.

.2 Trees 500 – 750 mm calliper use 12 mm diameter.

.3 Trees over 750 mm calliper use 15 mm diameter.

.7 Tree rings: fabricated from 3 mm galvanized wire encased in two ply reinforced 12 mm diameter rubber garden hose or equivalent.

.8 Arbortape: 19 mm flat, woven polypropylene tree tie material.

.9 Tree wrapping material: new clean, plain burlap minimum 2.5 kg/m2 mass and 150 mm wide.

.10 Anchors: T-bar steel stakes 40 x 40 x 5 x 500 mm long or wood stakes 38 x 38 x 500 mm long.

.11 Anti-desiccant: wax-like emulsion to provide film over plant surfaces reducing evaporation but permeable enough to permit transpiration. Product to be a horticulturally accepted one, and one approved by Departmental Representative.

.12 Wound dressing: horticulturally accepted non-toxic, non-hardening emulsion.

.13 Rodent guard: horticulturally accepted plastic / vinyl wrap with ventilation holes, or approved equivalent.

.14 Anti-Rodent Spray: horticulturally accepted, non-toxic, environmentally safe.

2.2 PLANT MATERIAL

.1 Quality and source to comply with latest edition of the "Canadian Standards for Nursery Stock", by the Canadian Nursery Landscape Association, referring to size and development of plant material and root ball. Measure plants when branches are in their natural position. Height and spread dimension refer to main body of plant and not from branch tip to branch tip. Use plant material of No. 1 grade. Conifers from Christmas tree lots are unacceptable.

.2 Plants shall be true to type and species shown on the project plans and at least one plant in each group of plants of the same species delivered to the project shall be tagged with a weatherproof label stating both the botanical and common name of the plants in the group.

.3 Plant material shall be of the species and size indicated.

.4 Additional plant material requirements.

.1 Use trees and shrubs with strong fibrous root systems; free of disease, insects, defects or injuries; and structurally sound. Use trees with straight trunks, well and characteristically branched for species. Plants must have been root pruned regularly, but not later than one growing season prior to arrival on site.

.2 Trees over 50 mm caliper must have been half root pruned during each of two successive growing seasons, the latter at least one growing season prior to arrival on site.

.3 Plant material that has come out of dormant stage and is too far advanced will not be accepted unless prior approval is obtained.

.4 Cold storage: approval shall be required for plant material which has been held in cold storage.

.5 Container-grown stock: acceptable if containers are large enough for root development. Trees and shrubs must have grown in container for minimum of one growing season but not longer than two. Root system must be able to "hold" soil when removed from container. Plants that have become root bound are not acceptable. Container stock must have been fertilized with slow releasing fertilizer.

.6 Balled and burlapped stock: coniferous and broad-leafed evergreens must be dug with soil ball. Deciduous trees in excess of 3 m height must have been dug with large firm ball. Root balls must include 75% of fibrous and feeder root system. This excludes use of native trees grown in light sandy or rocky soil. Secure root balls with burlap, heavy twine and rope. For large trees: wrap ball in double layer of burlap and drum lace with minimum 10 mm diameter rope. Protect root balls against sudden changes in temperature and exposure to heavy rainfall.

.7 Tree spade dug material: dig plant material with mechanized digging equipment of hydraulic spade of clam-shell type. Lift root ball from hole, place in wire basket designed for purpose and lined with burlap. Tie basket to ball with heavy rope. Take care not to injure trunk of tree with wire basket ties or rope. The following shall govern the material size allowable for transplant by tree spade method unless otherwise directed by the Departmental Representative.

Tree Spade Size	Caliper (taken 300 mm Above ground)	Tree Height
1120 mm	Maximum 100 mm	3.0 – 3.6 m
1680 mm	Maximum 150 mm	3.6 – 4.2 m
2140 mm	Maximum 200 mm	4.2 – 4.8 m

.8 Collected or native plant material: use only native trees indigenous to area into which they are to be transplanted. Select trees from reasonably open stands. Trees must have well developed crowns and must be characteristically branched. Not more than 40% of overall tree height may be free of branches. Collected or native plant material use is acceptable only upon written approval by Departmental Representative.

.9 Substitutions of plant material as indicated on planting plan are not permitted unless written approval has been obtained as to type, variety and size. Approved plant substitutions must be of equal size to those originally specified.

.10 In the event that discrepancies occur between the quantities of plants as indicated in the plant list and those indicated on the drawing, the plant quantities on the drawing shall govern.

.11 Rejected plant material shall be promptly removed from the project site.

Part 3 Execution

3.1 WORKMANSHIP

.1 Stake out location of trees and planting beds as per planting plan. Obtain approval prior to excavating.

.2 Apply anti-desiccant in accordance with manufacturer's instructions.

.3 Coordinate operations. Keep site clean and planting holes drained. Immediately remove soil or debris spilled onto pavement.

3.2 PLANTING TIME

.1 With the exception of container stock, plant material is to be planted only during dormant period before buds have broken, or after leaf drop in autumn, unless permission has been obtained from the Departmental Representative. Plant material noted for spring planting only, must be planted in dormant period.

.2 Plant material imported from region with warmer climatic conditions may only be planted in early spring or late fall.

.3 When permission has been obtained to plant deciduous plant material after buds have broken, spray plants with anti-desiccant to slow down transpiration prior to transplanting.

.4 Plant balled and burlapped evergreens in spring before bud break, or after the middle of August. Apply antidesiccant to evergreens before digging.

.5 Trees, shrubs and ground covers growing in containers may be planted throughout the growing season.

.6 Bare root stock to be used only when specified by the Departmental Representative, and to be planted only in early spring before bud break, or in fall after leaf drop.

.7 Plant only under conditions that are conducive to health and physical conditions of plants.

.8 Contractor to provide planting schedule. Extending planting operations over long period using limited crew will not be accepted.

3.3 EXCAVATION

.1 Shrub beds: excavate to minimum depth of 450 mm.

.2 Individual shrubs: excavate planting holes 450 mm deep and to a diameter twice that of the root ball or container.

.3 Trees 50 mm cal. and less excavate holes 600 mm deep with diameter of 500 mm greater than root spread of root ball.

.4 Trees larger than 50 mm cal. excavate to depth of at least 200 mm deeper than height of root ball, with width of 750 mm greater than diameter of root ball. In heavy soils, increase planting holes by 50 mm for each 100 mm of root ball diameter.

.5 Protect bottom of excavation against freezing.

.6 Remove water which enters excavations prior to planting. Ensure source of water is not ground water.

3.4 PLANTING

.1 Planting shall not be done in soil that is excessively moist or otherwise in a condition not satisfactory for planting in accordance with accepted horticultural practice.

.2 Plants in containers shall be planted and watered the same day the container is cut or removed.

.3 Plants shall be removed from containers in such a manner that the root ball is not broken. Plants with broken root balls or with root balls that fall apart while being planted will be rejected. Rough up sides of root ball, where roots are white (fleshy), to prevent the formation of girdling roots. If woody roots are circling/girdling remove to ensure new growth is directed away from trunk.

.4 Scarify bottom of planting hole to depth of 150 to 200 mm. Cover bottom of each excavation with minimum of 150 mm of soil mixture. If planting pits are dug with tree spade or power auger and 'glazing' occurs, scarify sides of planting pits as well.

.5 Plant trees and shrubs vertically with roots placed straight out in hole. Orient plant material to give best appearance in relation to structure, roads and walks.

.6 Place plant material to depth equal to depth they were originally growing in nursery.

.7 With balled and burlapped root balls, loosen burlap and cut away the top 1/3 without disturbing root ball. Do not pull burlap or rope from under root ball. With container stock, remove entire container without disturbing root ball. Non bio-degradable wrappings must be removed. When root balls are in wire baskets, cut off or fold back the top 1/3 of the basket without damaging root ball, so as to ensure that after planting no wire shall be present in the top 300 mm of soil.

.8 With frozen ball material, mulch planting pit to prevent freezing.

.9 Tree spade excavated material:

.1 Dig tree pit with same mechanical equipment as used to dig plant material. Ensure hole is upright as possible. Place in hole a mixture of planting soil, superphosphate fertilizer (0-20-2) at a rate of 0.6 kg per cubic metre, and enough water to create a soupy consistency. This will be forced up sides of ball as root ball is placed in hole.

.10 During the planting of bare-rooted stock, first shake backfill of planting soil among the roots.

.11 Tamp planting soil around root system in layers of 150 mm eliminating air voids. Frozen or saturated planting soil is not acceptable. When 2/3 of planting soil has been placed, fill hole with water. After water has completely penetrated into soil, complete backfilling.

.12 Build 100 mm deep saucer around outer edge of hole to assist with maintenance watering.

.13 Install rabbit / rodent guard to minimum height of 100cm with bottom and top snuggly secured around trunk.

.14 Anti-rodent spray: should be applied in late fall when leaves have fallen and the bark of the tree/shrub is dry. Repellent should be sprayed in a dry day when temperature is above freezing.

.15 When planting is completed, give surface of planting saucer dressing of organic 10-6-4 fertilizer at rate of 12 kg/100 m2 for shrub beds or 40 to 50 g/mm of caliper for trees. Mix fertilizer thoroughly with top layer of planting soil and water in well.

3.5 TREE SUPPORT

.1 Tree support is shown on planting details.

.2 Install Arbortape using Arborknot techniques per manufacturer's instructions.

.3 Staking for trees up to 3 m and evergeens up to 2 m in height: Backfill planting hole 2/3, drive T-rail stake 900 mm into bottom of pit, taking care not to damage main roots. Fasten trunk to stake or anchor with tree ring. Different methods of fastening tree trunk to stake or anchor are acceptable if no damage to bark of tree will occur. Obtain approval prior to use other methods.

.4 Guy wires for trees up to 150 mm caliper:

.1 For deciduous trees taller than 3 m and evergreens taller that 2 m, fasten three wires to tree where a branch will prevent wires from slipping down. Use rubber hose to prevent abrasion of bark.

.2 Fasten guy wires to anchors at distance from tree base equal to height of where wire is attached to trunk. Break wires, install wire tighteners and tighten slightly.

.3 Where guy wires are used close to pedestrian traffic ways, fasten approved flags to wire or paint turnbuckles orange to make them clearly visible.

.4 Use sufficient number of guy wires to support large shrubs.

.5 Guy wires for trees over 150 mm caliper:

.1 Maintain tree in correct position with 4 guys spaced at equal intervals.

.2 Fix guys at 2/3 height of evergreens, above bottom branches of deciduous trees or at least half tree height.

.3 Secure guys to anchors at 450 angle to trunk of tree.

.4 Position each anchor at right angles to trunk in pit 1200 mm deep. Tamp planting soil around root system in 150 mm layers to eliminate air voids.

.5 Secure guys to trees with four eyebolts spaced at vertical intervals of 150 mm minimum by drilling trunk same diameter as eyebolt. Use nuts and washers. Dress ends with wound dressing.

.6 Secure cable ends with cable splicing bolts.

.7 Where guy wires are used close to pedestrian traffic ways, fasten approved flags to wires or paint turnbuckles orange to make them clearly visible.

3.6 PRUNING

.1 Prune trees and shrubs after planting, as indicated, to compensate for loss of roots suffered during transplanting. Postpone pruning, of those trees where heavy bleeding may occur, until in full leaf. Employ clean sharp tools and make cuts flush with main branch, smooth and sloping as to prevent accumulation of water. Remove projecting stumps on trunks or main branches. Remove dead and injured branches and branches that rub causing damage to bark. Trim out crown of trees and shrubs without changing their natural shape. Do not damage lead branches or remove smaller twigs along main branches. Treat cuts in excess of 40 mm diameter and damaged parts with application of wound dressing.

3.7 MAINTENANCE

.1 Water once a week for first 4 weeks and then sufficiently thereafter to maintain optimum growing conditions. Ensure adequate moisture in root zone at freeze-up.

.2 Keep soil, within confines of planting saucer around trees and planting beds, shallowly cultivated and free from weeds.

.3 Spray plants to combat pests and diseases. Do not use DDT or sprays prohibited by Agriculture Canada.

.4 Keep tree guards, guy wires and rodent guard in proper repair.

.5 Provide adequate protection against winter damage including damage caused by rodents.

.6 Maintain plant material from date of planting up to end of warranty period.

.7 Remove truck wrapping, trees stakes, guy wires, and eyebolts at end of warranty period.

.8 Provide landscape maintenance as outlined in Section 32 93 20.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Supply and installation of mulches.

1.2 LAYING OUT WORK

.1 Lay out work and be responsible for accuracy. Provide the necessary personnel to assist the Departmental Representative in checking the work.

Part 2 Products

2.1 WOOD MULCH

.1 Untreated shredded fibres produced by mills in Northern Saskatchewan. Submit sample, to Departmental Representative for approval, prior to incorporation into the work.

2.2 GRANULAR MULCH

.1 Pea-gravel, 10-20 mm diam.; to match existing. Submit one (1) litre sample, to Departmental Representative for approval, prior to incorporation into the work.

2.3 LANDSCAPE FABRIC

.1 Geotex 801 Landscape Fabric, or approved equivalent.

Part 3 Execution

3.1 WOOD MULCH

.1 Install per tree planting and shrub planting details.

.2 In planting beds and buffer strip, carefully place landscape fabric with minimum 150mm overlap on parallel seams. Pin fabric securely in place.

.3 Install mulch to a minimum uniform compacted depth of 50 mm (100 mm loose) in watering saucers of trees in grass areas and planting beds as noted.

.4 Taper mulch to base of trees and shrubs ensuring that mulch does not touch base. Spray with water to settle mulch in place.

3.2 GRANULAR MULCH

.1 Rough grade to finish grade. Eliminate rough areas and compact as required for proper installation of granular mulch.

.2 Carefully place landscape fabric with minimum 150 mm overlap on parallel seams. Pin fabric securely in place.

.3 Install granular mulch to the depth of min 50 mm.

END OF SECTION

Part 1 General

1.1 WORK INCLUDED

.1 Maintenance of turf areas, mulched areas, planting beds, irrigation system and plant material from the start of the work until one year past the date of substantial performance, concurrent with the warranty.

.2 In general, annual maintenance is expected to occur from 01 May to 31 October. Site and weather conditions may extend or shorten the maintenance period.

1.2 COORDINATION & MANAGEMENT

.1 Coordinate maintenance operations with the Owner and any other contractors who may be working on site.

.2 Written guidelines are no substitute for on site observations. Modify maintenance procedures as required to provide the best care while adhering to sound horticultural principles.

1.3 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

2.1 CHEMICALS

.1 Insecticides, herbicides, fungicides, and other chemicals intended for use in the landscape shall be in accordance with Regina Public schools Municipal, Provincial and Federal regulations.

.2 Chemicals to be applied by a licensed applicator for the specific product.

2.2 EQUIPMENT AND TOOLS

.1 Equipment and tools shall be suitable for the work and in good working order.

.2 Mowers: size suitable to the work to be performed, in good working order and with sharp blades.

Part 3 Execution

3.1 WORKMANSHIP

.1 Program timing of operations to growth and weather conditions.

.2 Do each operation promptly, continuously and complete within reasonable time period.

.3 Do not store equipment and materials on-site without Owner approval.

.4 Collect and dispose of debris, refuse and excess material, from landscape areas, on daily basis.

.5 Operations and procedures shall be discussed with, and approved by, the Owner or his representative prior to commencement of work. Operations to be coordinated with work that may be undertaken by the Owner or others.

.6 Keep a maintenance logbook of work performed, date, time and personnel performing task. Provide a copy of monthly logs with monthly invoice.

.7 Conduct soil analysis in spring. Review fertilizer recommendations and compare with amounts recommended in this document; adjust as required.

.8 Contractor is responsible for keeping landscaped areas clean and free of trash during the period of landscape maintenance. Confirm with Owner place of trash disposal.

3.2 TURF MAINTENANCE

.1 General

.1 Maintain existing turf including mowing, fertilizer and weed control.

.2 Remove weeds, including their roots.

.3 Report vandalism and site maintenance problems and issues to the Owner.

.2 Spring Clean-up and Preparation:

.1 Remove all weeds and volunteer plants from turf areas.

.3 Watering:

.1 Ensure turf is watered twice per week or per irrigation schedule. A minimum moisture penetration of 100 - 150 mm is required. Specific site conditions may require adjustments to watering program in order to appropriately meet the turf water requirements.

.4 Mowing:

.1 Mow at regular intervals (minimum weekly or more frequent following fertilization) to keep grass length at 60 mm. Maximum recommended grass length is 75 to 90mm before cutting.

.2 Evenly distribute (do not remove) grass clippings throughout the turf areas.

.3 Maintain sharpened mower blades.

.5 Turf Fertilizing Guidelines:

.1 Apply a balanced fertilizer (such as 14-14-0) two times a year (May and August), as per manufacturer's directions. If growing problems are evident, apply a fertilizer that will eliminate soil deficiencies determined by soil analysis.

.2 Apply fertilizer when turf is dry and humidity is low. Use liquid fertilizer in areas of sub-surface irrigation. Water immediately after application.

.3 Uniformly apply to turf at the rate recommended by soil tests.

.6 Herbicides and Pesticides:

.1 Avoid the use of chemical control whenever possible.

.2 Use in accordance with the manufacturer's recommendations and in conformance with applicable regulations.

.7 Fall/Winter Preparation:

.1 Ensure turf is watered once every two to three weeks in the fall to harden off the lawn.

.2 Rake fallen leaves and remove from site

3.3 PLANT MATERIAL MAINTENANCE

.1 General:

.1 Maintain existing trees, shrubs and perennials including fertilizer, weed control and pruning.

.2 Remove weeds, including their roots, from planting beds.

.2 Spring Clean-up and Preparation:

.1 Remove all weeds and volunteer plants from planting beds.

.2 Hose down coniferous trees and shrubs to wash off winter grime.

.3 Cultivate tree wells. Place additional mulch where settling has occurred. Use mulch to match original installation.

.4 Tighten or adjust tree staking and guying (remove or install as necessary).

.5 Review pruning needs. Prune all dead or damaged branches from plants. Remove spent flowers, stems and leaves from perennials.

.3 Watering Program:

.1 Review soil moisture conditions during regular maintenance to ensure root systems are receiving an adequate supply of water. Around perennial and groundcovers, ensure top 50mm of soil below mulch is moist.

.4 Cultivation:

.1 Cultivate tree wells and planting beds once each month during the growing season to control weed growth and keep mulch from matting. Avoid damage to roots.

.2 Maintain depth of tree watering saucers at 100 to 150 mm.

.5 Pruning:

.1 Do not prune coniferous trees and shrubs unless limbs have been broken or extend into pedestrian traffic routes.

.2 Prune deciduous trees and shrubs as follows:

.1 Remove broken branches.

.2 Thin out the canopy by removing dead, dying, crossed, rubbing or weaker branches.

.3 Treat all cuts and scrapes 25 mm or larger with a horticulturally accepted non-toxic, non-hardening emulsion.

.3 Cut off spent flower and seed stalks below foliage levels when and as required for orderly appearance.

.6 Soil Fertilizing Guidelines:

.1 Fertilize trees and shrubs in May or June.

.2 Use a low-analysis or slow release fertilizer; formulation and application rates based on soil analysis, or as follows:

.1 For shrubs 1800 mm or taller: 0.5 - 2.5 kg fertilizer per year.

.2 For shrubs 1200 - 1800 mm high: 0.5 kg. fertilizer per year.

.3 For shrubs 1200 mm or shorter: 0.2 kg. fertilizer per year.

.4 Apply 0.2 kg. fertilizer for each 25 mm caliper as measured 300 mm above ground level.

.3 Apply liquid fertilizer on the ground or injected into the ground, extending to the edge of the tree canopy.

.7 Mulch:

.1 Maintain a uniform compacted mulch depth. Remove weeds and turf from mulched areas.

.2 Clean up any mulch that may have been displaced from planting beds and islands.

.8 Herbicides and Pesticides:

.1 Avoid the use of chemical control whenever possible.

.2 Use in accordance with the manufacturer's recommendations.

.9 Fall/Winter Preparations:

.1 Ensure plants are watered every three to four weeks in the fall to harden off trees and shrubs. As leaves drop off, if soil is moist, watering may be stopped until freeze-in. Be responsible for supply of water after irrigation system has been blown out.

.2 Cultivate shrub beds to loosen mulch. Foliage on perennials should be left for spring removal to assist in plant identification. Mulch perennial beds, if required.

.3 Rake fallen leaves from plant beds and remove from site.

3.4 PEST CONTROL

.1 Be responsible for control of destructive and invasive pests including, but not necessarily limited to, domestic animals, wild animals, birds, insects and rodents.

.2 Repair damage caused by pests; replace products as required to maintain vigorous landscape.

3.5 REPLACEMENTS

.1 Products and materials damaged by accidental causes or vandalism, after the date of Substantial Performance of the work, shall be promptly replaced as an additional service.

.2 Obtain Owner approval for additional charges prior to undertaking replacements.

3.6 MAINTENANCE MANUALS

.1 Submit four (4) copies of a landscape maintenance manual to Departmental Representative for review. Prepare in accordance with Close-Out Procedures. Include brief statements on the following aspects of work: mowing and care of turf; fertilizing; weed and disease control; watering; care of plant material; and pruning.

3.7 CONTRACTOR RESPONSIBILITY

.1 Prior to warranty expiration, ensure that the Owner is prepared to carry out maintenance operations. Familiarize grounds keeping staff with proper maintenance practices, in addition to the written instructions.

END OF SECTION