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DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

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END OF SPECIFICATION INDEX

1. General

1.1 Intent

.1 Work in Division 21, will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 21 or elsewhere, or whether defined in mechanical drawings or elsewhere.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:

- .1 Sprinklers
- .2 Fire Protection
- .3 Third party engineering fees

.3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are <u>not</u> detailed installation instructions.

.4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

.1 Refer to and comply with the following sections:

.1	General Requirements	Division 01
.2	Submittal Procedures	Section 01 33 00
.3	Delegated Design Submittals	Section 01 33 50
.4	Quality Control	Section 01 45 00
.5	Temporary Facilities and Controls	Section 01 51 00
.6	Execution Requirements	Section 01 73 00
.7	Closeout Procedures	Section 01 77 00
.8	Closeout Submittals	Section 01 78 00
.9	Demonstration and Training	Section 01 79 00
.10	General Commissioning (Cx) Requirements	Section 01 91 13

.11 Building Management Manual (BMM) Section 01 91 51

1.3 Related Work Specified In Other Sections

.1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

2. Products

.2 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

3. Execution

.3 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

1. General

1.1 Scope

.1 Gate valves

.2 Butterfly valves

.3 Check valves

1.2 Reference Documents

.1 American Society for Testing and Materials (ASTM):

.1	ASTM A126-04	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
.2	ASTM B21/B21M-06	Standard Specification for Naval Brass Rod, Bar, and Shapes
.3	ASTM B61-08	Standard Specification for Steam or Valve Bronze Castings
.4	ASTM B62-09	Standard Specification for Composition Bronze or Ounce Metal Castings
.5	ASTM B98/B98M-08	Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
.6	ASTM B139/B139M-07	Standard Specification for Phosphor Bronze Rod, Bar, and Shapes

.2 National Fire Protection Association (NFPA):

.1	NFPA 13-2013	Standard for the Installation of Sprinkler Systems
.2	NFPA 14-2010	Standard for the Installation of Standpipe Systems

.3 Manufacturers Standardization Society Standard Practices (Current Editions)

.1	SP-67	Butterfly Valves
.2	SP-70	Gray Iron Gate Valves, Flanged and Threaded Ends

.3	SP-71	Gray Iron Swing Check Valves, Flanged and Threaded Ends
.4	SP-80	Bronze Gate, Globe, Angle, and Check Valves
.5	SP-82	Valve Pressure Testing Methods

1.3 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body”

.1 Manufacturer’s name or trademark

.2 Pressure rating

.3 Flow direction

.3 Valves for fire protection service to be ULC Listed and FM Approved.

1.4 Shop Drawings

.1 Submit detailed shop drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. Products

.1 For complete General Duty Valve requirements refer to Section 23 05 23 – General Duty Valves for HVAC Piping.

3. Execution

.1 For complete General Duty Valve requirements refer to Section 23 05 23 – General Duty Valves for HVAC Piping.

END OF SECTION

1. General

1.1 Scope

.1 Pipe hangers and supports

.2 Sleeving for mechanical equipment

.3 Equipment bases and supports

.4 Pipe anchors

.5 Access Doors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of ANSI B31.1 Power Piping.

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

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, and provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.

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

.4 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.

.5 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.

.6 No percussion type fastening of any kind will be permitted without prior approval.

.7 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.

.8 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all domestic hot, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through and to project through both sides of wall.

.9 Provide sleeves for all piping through ceilings, floors and footings.

.10 Do not weld piping or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.

.11 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.

.12 Obtain approval prior to using percussion type fastenings.

.13 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

.1 Submit shop drawings for access doors.

2. Products

.1 For complete hanger, support and access door requirements for fire suppression refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3. Execution

.1 For complete hanger, support and access door requirements for fire suppression refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

.1 Painting and identification of equipment, piping and related components for the following:

.1 Fire Protection Systems

1.2 Related Work Specified in Other Sections

.1	General Requirements	Division 01
.2	Interior Painting	Section 09 91 23
.3	Common Work Results for HVAC	Section 23 05 00
.4	Identification for HVAC Piping and Equipment	Section 23 05 53

1.3 Reference Standards

.1 Canadian General Standards Board (CGSB)

.1 CGSB-1-GP-12c; Color Identification and Selection

.2 CAN/CGSB-24.3 – Identification of Piping Systems

.2 National Fire Protection Association (NFPA)

.1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems

.2 NFPA 14-2010, Standard for the Installation of Standpipe and Hose Systems

.3 American Society of Mechanical Engineers (ASME)

.1 ASME A13.1-2007, Scheme for the Identification of Piping Systems

.4 Federal Standard 595C – Colors

.5 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms

1.4 Quality Control

.1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.

.2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting Contractor, under the direction of the Division 21 contractor.

.3 Color code mechanical equipment and piping. Refer to Part 3 of this section.

.4 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

1.5 Definitions

.1 For the purposes of this Section, the following definitions apply:

.1 Concealed: Piping and equipment in trenches, shafts, furrings and suspended ceilings.

.2 Exposed: Piping and equipment in mechanical rooms or otherwise not “concealed”.

1.6 Equipment Protection and Clean-Up

.1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

2. Products

Not Applicable

3. Execution

.1 For complete identification requirements refer to Section 23 05 53 – Identification for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

.1 Equipment, piping, including sprinkler heads, valves, hangers and supports, sleeves, fire department connections, and accessories.

.2 Contractor shall be responsible for coordination of all fire alarm interlocks with Division 28.

1.2 General Requirements

.1 Provide complete sprinkler system as required by local codes and as indicated on drawings. Size of sprinkler system based on light hazard occupancy and ordinary hazard occupancy group 1.

.2 Provide sprinklers for areas as indicated and as required, including specialized rooms. Run piping concealed above furred ceilings and in joist to minimize obstructions. Expose only heads.

.3 Hydraulically size sprinkler system based on the actual water supply data which must be obtained from municipal utility.

1.3 Quality Assurance

.1 All municipal bylaws, provincial statutes and NFPA Standards governing the installation shall be strictly adhered to.

.2 Provide all labor and materials in accordance with the requirements of the fire marshal having jurisdiction. Comply fully with the rules and regulations stated in current National Building Code and the following NFPA Standards, those editions which are in effect locally and in the Province of Alberta.

.3 Guarantee that the quantities of sprinklers proposed meet the requirements of this specification. If the quantities are not within these requirements, provide additional sprinklers and their installation at no additional cost to the contract.

.4 Sprinkler equipment and installation shall be in accordance with the current standards and approved local Fire Commissioner.

.5 Equipment and installation shall meet the requirements of current edition of NFPA 13 - Standard for the Installation of Sprinkler Systems.

.6 Sprinkler equipment shall be installed by qualified contractors licensed and regularly engaged in installation of automatic fire sprinkler equipment.

.7 Refer to Section 21 05 00 – Common Work Results for Fire Suppression for welding requirements

1.4 Reference Standards

.1 National Fire Protection Association (NFPA)

.1 NFPA 13 2013 Standard for the Installation of Sprinkler Systems

.2 National Research Council (NRC)

.1 National Building Code (NBC) 2010

.2 National Plumbing Code of Canada (NPC) 2010

1.5 Submittals

.1 Submit four (4) copies of the preliminary layout showing head locations, pipe sizes, and pipe route for review by the consultant. Furnish additional heads which may be required for coordinated ceiling pattern without added cost, even though number of heads may exceed minimum code requirements.

.2 Submit to the consultant shop drawings and sprinkler hydraulic calculations bearing the approval seal of Professional Engineer specialized in Fire Protection.

.3 Submit cut sheets of equipment and accessories related standpipe and sprinkler system, fire booster pump and appurtenances for Consultant's approval.

.4 Submit completed hydrostatic test certificates and other certification of testing as required and to the owner's Underwriter.

1.6 Related Work Specified in Other Sections

.1 Common Work Results for Fire Suppression Section 21 05 00

1.7 Engineering Design Criteria

.1 Design system in accordance with NFPA 13, using following parameters:

.1 Hazard: To suit occupancy classification based on the quantity and/or combustibility of the building contents.

.2 Pipe size and layout:

.1 Hydraulic design in accordance with NFPA standards and the Owner's Insurance Underwriter requirements, whichever is more stringent.

.2 Sprinkler head layout: to NFPA 13 or as directed by Authority Having Jurisdiction.

.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 NFPA 13. Present findings to consultant.

.4 Zoning:

.1 System zoning as indicated or in accordance with NFPA standards.

1.8 Maintenance Data and Materials

.1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 – Closeout Submittals and Section 01 91 51 – Building Management Manual (BMM).

.2 Provide maintenance materials in accordance with Section 01 78 00 – Closeout Submittals.

.3 Provide spare sprinklers and tools as indicated in 2.7 – Spare Parts Cabinet.

2. Products

2.1 Acceptable Contractors

.1 Constant, SimplexGrinnell, Vipond, Viking

2.2 Pipe & Fittings

Size	Material	Fittings	Joint
1. Sprinkler and standpipe and hose system piping unless otherwise noted using threaded or cut grooved mechanical coupling joints:			
100 (4”) and smaller	ASTM A-53 Schedule 40, Grade A carbon steel	Standard weight cast iron to ANSI B16.4, 1206.6 kPa	Threaded, cut grooved
2. Sprinkler and standpipe and hose system piping unless otherwise noted using welded or rolled groove mechanical joints:			
25 – 100 (1” to 4”)	ASTM A-53, Grade A, carbon steel, Schedule 10	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove
50 (2”) and smaller	ASTM A-795 Schedule 5, steel, minimum wall thickness 1.45mm	ULC listed/FM approved Victaulic “Press-fit” cold drawn steel with Grade ‘C’ Butylene ‘O’ rings	ULC listed/FM approved Victaulic “Press-fit” cold drawn steel with Grade ‘C’ Butylene ‘O’ rings

Size	Material	Fittings	Joint
150 (6”)	ASTM A-53, Grade A, carbon steel, min. wall thickness 3.4mm	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove
200 – 250 (8” to 10”)	ASTM A-53, Grade A, carbon steel, min. wall thickness 4.78mm	Standard weight cast iron to ANSI B16.4, 1206.6 kPa, or ductile iron to ASTM A-536 with enamel coating	Welded or ULC/FM approved roll groove with EPDM gasket
Note: Use of CSA/ULC labeled plastic in sprinkler system will only be allowed with specific written application to the consultant and specific return written authorization from local fire authority having jurisdiction. Include comprehensive information on products and processes with written application. Non-specified pipe joining and pipe fitting methods such as T-drill and Press Fit are not permitted in any piping system covered under Division 21			

2.3 Unions, Flanges and Couplings

.1 Size 50mm (2”) and under: 1035 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.

.2 Sizes 65mm (2½”) and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. Gaskets shall be 1.5mm (16 gauge) thick pre-formed synthetic rubber bonded asbestos.

.3 Flange bolting: For systems up to 120°C (250°F), use carbon steel stud bolts, semi-finished, and heavy hex nuts, ASTM A307-GrB.

.4 Rigid grooved mechanical couplings shall have an angle bolt pattern design and shall provide system support and hanging requirements in accordance with ASME B31.1. Rigid couplings shall be used in all locations unless otherwise noted. Standard of acceptance Victaulic Style 07

.5 For grooved mechanical couplings fire protection service the gasket material shall be Grade “E” EPDM compound (green color coded stripe) conforming to ASTM D-2000 designation. Grade “E” gaskets are UL/ULC classified to ANSI/NSF 61 for -34°C to 110°C (-30°F to +230°F) operating temperature range. Any deviations from the above in the way of special lubricants or special clauses in the manufactures literature as to limitations on hot water must be brought to the attention of the engineer and may not be accepted.

.6 Official submission of shop drawings required.

2.4 Valves, Supports and Sleeves

.1 Valves shall conform to Section 21 05 23 – General Duty Valves for Water Based Fire Suppression Systems.

.2 Pipe hangers, supports and sleeves shall conform to Section 21 05 29 – Hangers and Supports for Fire Suppression Piping and Equipment.

.3 Pipe and valve identification shall conform to Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.

2.5 Sprinkler Heads

.1 Temperature rating on fusible links shall suit specific hazard area and ceiling temperature with minimum margin of safety 10°C (50°F).

.2 All sprinkler heads shall be of quick response type, and shall be designed and installed in accordance with their ULC listing. Sprinklers are to bear certification marking.

.3 Semi-Recessed Heads Pendant type sprinkler heads with white finish and white escutcheon. Standard Response: Reliable Model G/F1, Quick Response: Reliable Model GFR/F2.

.4 Pendant Heads: Standard pendant heads with white finish with white escutcheon except in areas without suspended ceilings. Standard Response: Reliable Model G, Quick Response: Reliable Model GFR.

.5 Concealed Heads: Concealed heads with cover plate, white paint finish. Confirm if special finishes are required with Architect prior to ordering. Standard Response: Reliable Model GI, Quick Response: Reliable Model G4FR.

.6 Upright Heads: Standard upright, brass finish. Standard Response: Reliable Model G, Quick Response: Reliable Model GFR.

.7 Sidewall Heads: Standard sidewall heads with chrome plated finish and white escutcheon. Standard Response: Reliable Model G, Quick Response: Reliable Model GFR.

.8 Dry Pendant Heads: Dry recessed pendant sprinkler with white finish, white escutcheon and field measured drop nipple. Reliable Model G3.

.9 Dry Sidewall Heads: Dry horizontal sidewall sprinkler, polished chrome finish with escutcheon and field measured extension nipple. Central Model H-1.

2.6 Supervisory Switches

.1 General: Switches to NFPA 13 and ULC listed for fire service.

.2 All valves that control the supply of water to automatic sprinklers shall be electrically supervised to indicate a supervisory signal on the fire alarm system.

.3 Isolation valves supervisory switch:

.1 ULC listed supervisory switch one or two sets single pole double throw contacts normally open or normally closed contacts. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.5 Amps at 30 VDC.

.4 Water flow switch:

.1 ULC listed paddle type water flow switch with retard device with one or two sets of single pole double throw normally open or normally closed contacts. Contacts to be rated a minimum 15.0 Amps at 125/250 VAC and 2.0 Amps at 30 VDC. Cover shall incorporate tamper resistant screws.

2.7 Siamese Fire Department Connection

.1 Provide two-way 65x65x100mm (2½”x2½”x4”) flush mounted Siamese fire department connection with brass finish, local fire department thread, plugs and chains, 12mm (½”) automatic drip piped to drain with wall plate marked "Standpipe Fire Department Connection”. National Fire Model 229 flush fire department connection or approved equivalent.

.2 Siamese connection to meet NFPA 14 requirements and be ULC listed. Type and location as indicated. Thread specifications to be compatible with local fire department.

.3 Include straightway check valve and manual drain valve with hose end connection.

.4 Siamese fire department connection for sprinkler system shall match connection for standpipe and hose system.

2.8 Pressure Gauges

.1 Gauges to be ULC listed and to Section 21 05 19 - Meters and Gauges for Fire Suppression Systems.

.2 Shall have maximum limit of not less than twice normal working pressure at point where installed.

.3 A pressure gauge with a connection not smaller than 6mm (1/4”). shall be installed at the system main drain, at each main drain associated with a floor control valve, and on the inlet and outlet side of each pressure-reducing valve. Each gauge connection shall be equipped with a shutoff valve and provisions for draining.

2.9 Spare Parts Cabinet

.1 For storage of maintenance materials, spare sprinkler heads and sprinkler wrench.

.2 Construct to sprinkler head manufacturers standard.

.3 Provide on wall near sprinkler valve, cabinet containing extra sprinkler heads of each type and a wrench suitable for each head type. Six (6) extra sprinkler heads for less than

300 sprinklers, 12 for 300 to 1000 sprinklers, and 24 for over 1000 sprinkler heads of each type.

2.10 Backflow Preventer

.1 Provide on sprinkler take-off from water supply ULC approved double check valve assembly with all necessary test cocks, drain valves and OS & Y gate valves on both sides of check valves. Ames 2001SS or equivalent

2.11 Antifreeze Systems

.1 Provide a ULC approved reduced pressure backflow prevention assembly with OS&Y gate valves, drain funnel and test cocks. Drain funnel to be permanently piped to a floor drain.

.2 Provide diaphragm type expansion tank c/w pressure gauge. The expansion tank to be sized to suit capacity of piping in accordance with NFPA 13.

.3 Provide fill connection and drain connections with all necessary valves in accordance with NFPA 13.

.4 Antifreeze system to be filled with 50% propylene glycol 50% water mixture to maintain protection from freezing conditions. Verify that the solution will provide protection to -51°C (-60°F).

3. Execution

3.1 Installation

.1 Install, inspect and test to acceptance with NFPA 13 **[**FC-403**]** and local authorities.

.2 Protect sprinkler heads from mechanical injury by standard guards in all mechanical and electrical rooms, including custom ventilation unit vestibules and within 3 meters (10’-0”) either side of crawlspace access walkways.

.3 Locate outside alarms on wall of building adjacent to Siamese fire department connection.

.4 Provide on sprinkler system take-off from water supply ULC approved double check valve assembly.

.5 All sprinkler system isolation valves, including those on glycol loops (in areas subject to freezing), shall have fire alarm contacts that can be monitored on the building fire alarm system. Coordinate contact type and wiring with Division 26.

.6 Locate sprinkler heads in ceilings in order to maintain the pattern with lights, diffusers, etc. In other areas, arrange layouts and head locations as to avoid interference with other equipment and materials. Sprinkler head locations shall be located symmetrically within each room or area but shall not exceed the manufactures ULC listed maximum spacing. Final layout to be based on architectural and mechanical shop drawing reviews.

.7 Provide sprinkler inspector’s test and flow test connections as per NFPA 13.

.8 Install water flow indicators where indicated.

.9 Provide metal pan shielding for equipment in electrical room and communication room.

.10 Locate zone shut-off valves visible from the floor. Do not conceal from view, locate in janitor, storage rooms, or stairwells unless approved by the Engineer.

.11 Identify all piping and isolation valves in accordance with Section 21 05 53 – Identification for Fire Suppression Piping and Equipment.

3.2 Fire Protection System Tests

.1 Sprinkler System: Test as required by the edition of NFPA 13 noted in the Alberta Building Code 2006 and the authorities having jurisdiction. Complete certificates for test results and submit.

.2 Underground Fire Mains: Test as required by current edition of NFPA 24, and by authority having jurisdiction. Complete certificates for test results and submit.

3.3 Piping – Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

.3 Use Victaulic roll grooving tools to groove pipe in accordance with manufacturer’s specifications. Use copper rolls for copper pipe and stainless steel rolls for stainless steel pipe as provided by Victaulic.

3.4 Piping – Connection

.1 Make screwed joints with full cut standard taper pipe threads with approved Teflon tape or non-toxic joint compound applied to male threads only, equal to Jet-Lube V-2 multi-purpose thread sealant.

.2 Use grooved mechanical couplings and mechanical fasteners as manufactured by Victaulic where allowed.

.3 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

.4 Provide dielectric type connections wherever jointing dissimilar metals in open systems. Brass adapters and valves are acceptable.

3.5 Piping – Routes and Installation

.1 Confirm requirements of main line routing with consultant prior to hydraulic design. Route piping in an 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 furring to a minimum.

.2 Co-ordinate the installation of sprinkler piping with all other trades, services and structure.

.3 Sprinkler piping is to be sloped towards the system low points in accordance with NFPA 13. Sprinkler piping to be arranged to minimize the number of auxiliary drains required to collect condensation and to drain system low points. Extend drain lines to the floor level within the reach of a floor drain with a 15m (50’-0”) hose.

.4 Equip low points with 20mm (¾”) drain valves and hose nipples.

.5 Pipe the discharge from all relief valves, safety valves, vents, drains, and equipment to the nearest building drain.

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

.7 Provide clearance for proper access to valves, air vents, drains and unions.

.8 Install piping material specified as inside the building to 1m (3’-0”) outside of building.

.9 Yellow jacket all buried steel lines. Test all buried lines prior to backfill with holiday detector, "JEEPING". All lines exposed to outdoors (unless insulated and clad) to be painted. Repair any damaged covering.

END OF SECTION

1. General

1.1 Scope

.1 Provide for flushing and disinfection of domestic water systems.

.2 Isolate and bypass equipment listed in Clause 3.1.

1.2 Quality Assurance

.1 Provide chemical treatment, chemicals and equipment by an agency that specializes in this type of work. This work shall be directed by the water treatment agency who, upon completion, shall certify that the process is satisfactory and submit a report outlining the cleaning operation and the treatment process.

.2 Provide chemical treatment as specified herein and provide written reports. Reports shall be signed by the chemical treatment agency, mechanical contractor and commissioning agency.

.3 Include for the costs of an independent testing agency, selected by the Owner, to take samples of domestic water, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should the lab results prove that standards for drinking water quality have not been met, the Contractor shall correct the deficiency and cover the costs of the independent testing agency to take additional samples and tests.

.4 All equipment, service and chemicals shall be from one supplier.

1.3 Submittals

.1 Submit shop drawings including proposed chemicals, quantities, procedures and analysis reports to be used on this project. Provide written operating instructions and system schematics.

.2 Provide written reports containing log and procedure of system cleaning and degreasing, giving times, dates, conditions of water and problems and actions encountered.

.3 Submit a written report on system operations.

1.4 Acceptable Agency

.1 Specified Technical Sales; Betz Chemicals, Solutions Water Management Ltd, Sumco Technologies Ltd.

.2 Chemical treatment agency shall provide equipment, chemicals and site supervision so as to fully comply with all requirements and their intent contained within this specification section.

2. Products

2.1 Materials

.1 Provide sufficient chemicals to treat domestic water systems and test the systems from the time of activation and acceptance of the building.

.2 Chemicals used must comply with environmental and health standards applicable to the usage on this project.

.3 Domestic Water System: Sodium hypochlorite conforms to ANSI/AWWA B301.

3. Execution

3.1 Piping General

.1 Ensure reasonable care is exercised to prevent debris, dirt and other foreign material from entering the pipe during construction. This is to include proper protection of piping on site prior to installation, temporary caps on partial systems, and complete evacuation of moisture within systems being hydrostatically pressure tested.

.2 Chemical treatment agency shall, in conjunction with the mechanical contractor, review connections for complete draining and venting of the systems. The mechanical contractor shall provide adequate drain connections to completely drain the systems within one hour.

.3 Protect and/or remove control devices from systems during cleaning. All terminal control valves shall be in open position during cleaning. Particular attention is to be made to control valves which have a normally closed position.

.4 Make systems completely operational, totally filled, thoroughly vented, and completely started.

3.2 System Cleaning

.1 Pipes intended to carry potable water shall be disinfected before being placed in service. Disinfection procedures shall conform to AWWA C651 as hereinafter modified or expanded, and the requirements of any governing agency having jurisdiction.

.2 Flushing

.1 Before disinfecting, the mechanical contractor shall flush all foreign matter from the pipeline. He/she shall provide hoses, pumps, temporary pipes, ditches, etc., as required to dispose of flushing water without causing damage to adjacent properties. The flushing velocities shall be at least 2.5 FPS. For large diameter pipe, where it is impractical or impossible to flush the pipe at 2.5 FPS velocity, the pipeline shall be cleaned in place from the inside by brushing and sweeping, then flushing the line at a lower velocity.

.3 Disinfection Mixture

.1 The mechanical contractor shall prepare the disinfection mixture with a chlorine-water solution having a free chlorine residual of 40 - 50 PPM. The disinfection mixture shall be prepared by injecting calcium or sodium hypochlorite and water into the piping and allowing it to flow at a measured rate so that water-chlorine solution is of the specified strength.

.2 If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick paste, then thin to approximately a one percent solution (10,000 PPM Chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a one percent solution.

.4 Point of Application

.1 The chlorine mixture shall be injected into the piping to be treated at the beginning of the line, and through a corporation stop or suitable tap in the top of the line. Water from the existing system or other approved sources shall be controlled so as to flow slowly into the newly installed pipe during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 40-50 PPM of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Check valves shall be used if deemed necessary. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.

.5 Retention Period

.1 Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the 24-hour period, the disinfection mixture shall have a strength of at least 25 PPM of chlorine.

.6 The above procedure shall be repeated at the mechanical contractor’s expense if the free chlorine level drops below the minimum requirements.

.7 All valves, fixtures and other appurtenances shall be operated during disinfection to ensure that the disinfection mixture is dispersed into all parts of the line, including dead ends, new services and similar areas that otherwise may not receive the treated water. The water treatment representative shall analyze and record the free chlorine residual at the farthest fixtures from the injection point.

.8 After chlorination, the water from the line shall be flushed until it meets health department requirements.

.9 Disposal of Disinfection Water

.1 Disposal of disinfecting water shall be done in an approved manner. Disinfecting water should not be allowed to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations.

END OF SECTION

1. General

1.1 Intent

.1 Work in Division 22 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 22 or elsewhere, or whether defined in mechanical drawings or elsewhere.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:

- .1 Water treatment
- .2 Building plumbing

.3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are <u>not</u> detailed installation instructions.

.4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

.1 Refer to and comply with the following sections:

.1	General Requirements	Division 01
.2	Submittal Procedures	Section 01 33 00
.3	Delegated Design Submittals	Section 01 33 50
.4	Quality Control	Section 01 45 00
.5	Temporary Facilities and Controls	Section 01 51 00
.6	Execution Requirements	Section 01 73 00
.7	Closeout Procedures	Section 01 77 00
.8	Closeout Submittals	Section 01 78 00
.9	Demonstration and Training	Section 01 79 00
.10	General Commissioning (Cx) Requirements	Section 01 91 13
.11	Building Management Manual (BMM)	Section 01 91 51

1.3 Related Work Specified In Other Sections

.1 For complete common work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

2. Products

.1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

3. Execution

.1 For complete Common Work requirements refer to Section 23 05 00 – Common Work Results for HVAC.

END OF SECTION

1. General

1.1 Scope

.1 Flexible pipe connections

.2 Expansion joints and compensators

.3 Pipe loops, offsets, and swing joints

1.2 Reference Standards

.1 Conform to Standards of "Expansion Joint Manufacturers Association" and manufacturer's recommendations.

1.3 General Requirements

.1 Select all expansion compensators for the pressure and temperature to suit the service. Base axial traverse on -17.8°C (0°F), ambient to corresponding fluid temperature plus 25% safety factor.

.2 Assume 60°C (140°F) for domestic hot water.

1.4 Inspection

.1 Provide inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

1.5 Submittals

.1 Flexible pipe connector shop drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions 300mm (12”) and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.2 Expansion joint shop drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.6 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable Manufacturers

.1 Flexible Pipe Connections: Flex-Hose, Flexonics, Mason, Metraflex, Minnesota Flexible Corporation

.2 Expansion Joints & Compensators: Adsco, Flex-Hose, Flexonics, Mason, Metraflex

2.2 Flexible Pipe Connectors

.1 Flexible Rubber Spools: Neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa (150 psi) at 120°C (250°F). Union end connections for sizes 50mm (2”) and under; floating galvanized ductile iron flanges for sizes over 50mm (2”).

.2 Spherical Rubber Spools: Neoprene single sphere elbow connector, construction and service rating same as 2.2.1 above.

.3 Braided Spools for Copper Piping: Stainless steel inner core and braid brazed to copper tube ends, suitable for 1035 kPa (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50m (2”) diameter, flanged for 65mm (2½”) diameter.

2.3 Expansion Joints

.1 Copper piping: Laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud; suitable for 1035 kPa (150 psi) at 260°C (500°F).

.2 Steel piping up to 100mm (4”): Laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50mm (2”), flanged ends for sizes 65mm (2½”) and over; internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel piping 100mm (4”) and over: Guided externally pressurized laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring suitable for 1035 kPa (150 psi) at 260°C (500°F).

2.4 Pipe Guides

.1 4 finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300mm (12”).

2.5 Anchors

.1 Anchors shall securely attach piping to structural members. Size the anchors to accommodate the forces due to the pipe expansion and weight.

.2 Construct anchors from steel plate and channel. Where bolts secure anchor to the structure, weld the bolts to the plate.

.3 Arrange anchors so that bolts are in shear, not in tension.

.4 Provide anchors on both sides of expansion devices, as indicated on the drawings, and as required to control the flexing of the piping system.

2.6 Expansion Loops

.1 Provide expansion loops as required. The three legs of the expansion loop shall be equal.

.2 Cold springing of the expansion loop up to 50% of the expansion considered is permitted.

3. Execution

3.1 Application

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the drawing.

.2 Provide structural work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints. Minimum two guides on each side of expansion joints.

3.2 Installation

.1 Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.

.2 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.3 Install flexible connectors and expansion joints in accordance with manufacturer's instructions.

.4 Do not compress or expand connector during installation.

.5 Make adequate allowance for expansion and contraction of piping using expansion joints, flexible connections, pipe loops or offsets as indicated and as required. Properly guide and anchor all piping and install expansion joints in strict accordance with manufacturer’s instructions and ASHRAE Handbooks.

.6 Provide for expansion where pipe temperature is higher than ambient and where the straight runs are over 20 meters (65 feet) or as indicated or where piping crosses and will be affected by a building expansion joint.

.7 Weld or clamp anchors to the pipe and fasten to the building structure or embed in concrete pier such that all forces and thrusts acting at the anchor point are restrained. Submit proposed method of anchoring for approval. Also refer to ANSI B31.1 for methods of fabricating anchors and guides.

.8 Anchor horizontal runs of brass and copper pipe and tubing over 15.3 meters (50 feet) in length to wall or floor construction. Locate anchors near the mid-points of the runs so as to force the expansion equally to the ends or in a direction where expansion can take place without excessive strain.

.9 Install pipe guides per manufacturer’s instructions and recommendations or place first guide maximum of four pipe diameters and second guide maximum of fourteen pipe diameters away from expansion joints on each side.

.10 All pipe guides to be securely anchored to building structure. Obtain approval for anchoring method.

END OF SECTION

1. General

1.1 Scope

.1 Provide meters, gauges and taps where shown on drawings and/or specified herein.

1.2 Reference Documents

.1 American Society of Mechanical Engineers (ASME):

  .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition [1971].

.2 Health Canada/Workplace Hazardous Materials Information System (WHMIS):

.3 Material Safety Data Sheets (MSDS).

1.3 Submittals

.1 Submit show drawings in accordance with Section 23 05 00 – Common Work Results for HVAC.

.2 Submit shop drawings of proposed products to the engineer for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges, to the engineer for review.

.4 Submit list of all meters, including location, service, flow and corresponding reading for flow.

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable Manufacturers

1.	Thermometers:	Ashcroft, Marsh Bellofram, Trerice, Weiss, Weksler, Wika, Winters
2.	Pressure Gauges:	Ashcroft, Marsh Bellofram, Trerice, Weiss, Weksler, Wika, Winters

3. Positive Displacement Meters: Badger, Neptune, Rockwell
4. Turbine Flow Meters: Badger, Neptune, Onicon

2.2 Thermometers

.1 Dial Thermometers: 75m (3") diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket or flange and bushing, glass cover, adjustable pointer.

.2 Mercury Thermometer: Red reading mercury filled, 2° graduations, plastic or aluminum case, 230mm (9") scale, straight shank, separable socket, adjustable angle.

.3 Provide separable brass wells to suit pipe diameter and extensions for insulation. For duct thermometers, provide extension stems, aluminum fastening flange and extension for insulation.

.4 Thermometer range to suit service.

.5 Graduate thermometers with Fahrenheit **and** Celsius scales.

2.3 Pressure/Temperature Taps (Pete's Plugs)

.1 Fitting to allow a 3mm (12 gauge) O.D. plug-in gauge to measure temperature or pressure.

  .1 Maximum pressure: 3450 kPa (500 psi)

  .2 Maximum temperature: 135°C (275°F)

.2 Fitting constructed of:

  .1 6mm (¼") NPT brass body with hex head screw cap and gasket.

  .2 Protective screw cap to have retaining strap.

  .3 Two self-closing valves constructed of nordel.

.3 Test kit including the following:

  .1 One 65mm (2½") diameter pressure gauge with 3mm (12 gauge) O.D. plug-in stem.

  .2 Two 45mm (1¾") diameter temperature gauges with 3mm (12 gauge) O.D. x 125m (5") plug-in stem, range 0°C to 110°C (32°F to 230°F).

  .3 All above in protective carrying case with operating instructions.

.4 Installation:

.1 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.

.2 Provide one pressure/temperature taps test kit.

2.4 Pressure Gauges

.1 100mm (4”) diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Pressure gauges shall be liquid filled with ½% accuracy in locations subject to vibration (on pumps, air handling units, and chillers), and 1% accuracy in all other locations. Provide needle valve and syphon for steam service, pulsating damper and ball valve for water service.

.2 Provide each gauge with brass gauge cock or needle valve.

.3 Pressure range to suit service.

2.5 Positive Displacement Meters

.1 Cold Water Lines: Displacement type, magnetic drives conforming to ANSI/AWWA C700, bronze body, sealed register, stainless steel trim, impulse contractor for remote registration by control system and/or control of chemical treatment.

.2 High performance turbine meter type conforming to ANSI/AWWA C701, no lead bronze body, sealed register, stainless steel trim, impulse contactor for remoter registration by control system. Unit to be complete with strainer.

.3 Provide positive displacement meters where indicated on drawings.

3. Execution

3.1 Thermometers – Installation

.1 Provide thermometers at the inlet and outlet side of all equipment and components which create a temperature difference for both air and water circuits.

.2 Thermometer locations are generally indicated, however, additional units may be required based on as-built conditions.

.3 Check all thermometers for accuracy and recalibrate where necessary before work is handed over.

3.2 Pressure Gauges – Installation

.1 Provide pressure gauges at the inlet and outlet side of all components which create a pressure difference.

.2 Pressure gauge locations are generally indicated, however, additional units may be required based on as-built conditions.

.3 Check all pressure gauges for accuracy and recalibrate where necessary before work is handed over.

3.3 Meters, Gauges and Flow Measuring Devices

.1 All mechanical equipment shall be provided with instrumentation or test ports to verify critical parameters, such as capacity, pressures, temperatures and flow rates.

.2 Thermometers and pressure gauges are required on all pumps.

.3 Provide one pressure gauge per pump. Install taps before strainers and on suction and discharge of pump. Pipe to gauge with ball isolation valve on each tap.

.4 For gauges on liquid service, provide tee in piping with bronze pulsation damper and ball isolation valve.

.5 Select gauges so that normal operating point is approximately mid-point of instrument range.

.6 Install gauges between equipment and first fitting valve.

.7 Install gauges in locations and angles that are easily readable from normal sight.

.8 Provide extensions where pressure gauges or thermometers are installed through insulation.

.9 Install pressure/temperature taps into threaded pipe nipples welded to wall of pipe. Locate fittings in accessible spaces.

.10 Install positive displacement meters with isolating valves. Provide valved bypass for liquid service meters.

.11 Install flow meters in uninterrupted straight pipe, minimum 5 pipe diameters downstream and 10 pipe diameters upstream, or according to manufacturer’s recommendations. Minimum 3 pipe diameters lateral from any physical obstruction to insertion of meter probes.

.12 Flow measuring devices shall be capable of communication with the central building automation system.

.13 Water flow devices shall conform to the requirements of ASHRAE Standard 90.1.

.14 On pipes 65mm (2½”) and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.4 Meters and Gauges Installation Schedule

.1 Positive Displacement Meter:

.1 Domestic Cold Water

.2 And where shown on drawings

.2 Flow Meters:

.1 Where shown on drawings

.3 Pressure Gauges:

.1 Domestic Cold water to Standpipe and/or Sprinkler

.2 Domestic Cold Water Supply to Building

.3 Pumps

.4 Expansion Tanks

.5 And where shown on drawings

.4 Pressure/Temperature Taps - Pete's Plugs:

.1 All control sensor tappings

.2 Both sides of two-way control valves larger than NPS 30mm (1¼”)

.3 Omit pressure/temperature taps in locations where pressure gauges and thermometers are indicated

.4 And where shown on drawings

.5 Thermometers:

.1 Domestic hot water heaters (outlet)

.2 And where shown on drawings

.6 Static Pressure Taps:

.1 On each side of balance valves

.2 And where shown on drawings

END OF SECTION

1. General

1.1 Scope

.1 Gate valves

.2 Globe or angle valves

.3 Ball valves

.4 Butterfly valves

.5 Check valves

.6 Plug valves

.7 Drain valves

.8 Circuit balancing valves

.9 Strainers

1.2 Reference Documents

.1 American Society for Testing and Materials (ASTM):

.1	ASTM A126-04	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
.2	ASTM B21/B21M-06	Standard Specification for Naval Brass Rod, Bar, and Shapes
.3	ASTM B61-08	Standard Specification for Steam or Valve Bronze Castings
.4	ASTM B62-09	Standard Specification for Composition Bronze or Ounce Metal Castings
.5	ASTM B98/B98M-08	Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
.6	ASTM B139/B139M-07	Standard Specification for Phosphor Bronze Rod, Bar, and Shapes

.2 National Plumbing Code 2010

.3 Manufacturers Standardization Society Standard Practices (Current Editions)

.1 SP-67 Butterfly Valves

.2 SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends

.3 SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends

.4 SP-80 Bronze Gate, Globe, Angle, and Check Valves

.5 SP-82 Valve Pressure Testing Methods

.6 SP-110 Ball Valves, Threaded Socket-Welding, Solder Joint, Grooved and Flared Ends

1.3 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body”

.1 Manufacturer’s name or trademark

.2 Pressure rating

.3 Flow direction

1.4 Shop Drawings

.1 Submit detailed shop drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. Products

.1 For complete General Duty Valve requirements refer to Section 23 05 23 – General Duty Valves for HVAC Piping.

3. Execution

.1 For complete General Duty Valve requirements refer to Section 23 05 23 – General Duty Valves for HVAC Piping.

END OF SECTION

1. General

1.1 Scope

.1 Pipe hangers and supports

.2 Flashing for mechanical equipment

.3 Sleeving for mechanical equipment

.4 Equipment bases and supports

.5 Pipe anchors

.6 Access Doors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of ANSI B31.1 Power Piping.

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, and provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.

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

.4 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.

.5 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.

.6 No percussion type fastening of any kind will be permitted without prior approval.

.7 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.

.8 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all domestic hot, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through and to project through both sides of wall.

.9 Provide sleeves for all piping through ceilings, floors and footings.

.10 Do not weld piping or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.

.11 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.

.12 Obtain approval prior to using percussion type fastenings.

.13 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

.1 Submit shop drawings for access doors.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

.1 For complete hanger, and support requirements for plumbing refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

3. Execution

.1 For complete hanger, support and access door requirements for plumbing refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

.1 Painting and identification of equipment, piping and related components for the following:

- .1 Plumbing Systems

1.2 Reference Standards

.1 Canadian General Standards Board (CGSB)

- .1 CGSB-1-GP-12c; Color Identification and Selection
- .2 CAN/CGSB-24.3 – Identification of Piping Systems

.2 American Society of Mechanical Engineers (ASME)

- .1 ASME A13.1-2007, Scheme for the Identification of Piping Systems

.3 Federal Standard 595C – Colors

.4 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms.

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related Work Specified in Other Sections

.1	General Requirements	Division 01
.2	Interior Painting	Section 09 91 23
.3	Common Work Results for HVAC	Section 23 05 00
.4	Identification for HVAC Piping and Equipment	Section 23 05 53

1.6 Quality Control

.1 Coordinate color coding of piping and equipment with work of Section 09 91 23 – Interior Painting.

.2 All painting identified in this section is to be performed by Section 09 91 23 – Interior Painting, under the direction of the Division 22 contractor.

.3 Color code mechanical equipment and piping. Refer to Part 3 of this section.

.4 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

1.7 Definitions

.1 For the purposes of this Section, the following definitions apply:

.1 Concealed: Piping and equipment in trenches, shafts, furrings and suspended ceilings.

.2 Exposed: Piping and equipment in mechanical rooms or otherwise not “concealed”.

1.8 Equipment Protection and Clean-Up

.1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

2. Products

Not Applicable

3. Execution

.1 For plumbing piping and equipment identification requirements refer to Section 23 05 53 – Identification for HVAC Piping and Equipment.

END OF SECTION

1. General

1.1 Scope

.1 Domestic water systems (hot, cold, recirculation), ambient to 82°C (180°F)

.2 Equipment insulation

.3 Adhesives, tie wires, tapes

.4 Recovery materials

1.2 Reference Documents

.1 American Society for Testing and Materials (ASTM)

1.	ASTM B209M	Specification for Aluminum and Aluminum Alloy Sheet and Plate
2.	ASTM C335	Steady State Heat Transfer Properties of Pipe Insulation
3.	ASTM C411	Hot-Surface Performance of High Temperature Thermal Insulation
4.	ASTM C423	Standard Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method
5.	ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement
6.	ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
7.	ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
8.	ASTM C547	Mineral Fiber Pipe Insulation
9.	ASTM C553	Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
10.	ASTM C612	Mineral Fiber Block and Board Thermal Insulation
11.	ASTM C921	Practice for Determining the Properties of Jacketing Materials for Thermal Insulation
12.	ASTM C1071	Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
13.	ASTM G21	Standard of Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

.2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1. ASHRAE Standard 90.1 — Energy Standard for Buildings except Low Rise Residential Buildings

.3 Canadian General Standards Board (CGSB):

1. CAN/CGSB-51.2 — Thermal Insulation, Calcium Silicate for Piping, Machinery and Boilers
2. CAN/CGSB-51.9 — Mineral Fiber Thermal Insulation for Piping and Round Ducting
3. CAN/CGSB-51.10 — Mineral Fibre Board Thermal Insulation
4. CAN/CGSB-51.11 — Mineral Fibre Thermal Insulation Blanket
5. CAN/CGSB-51.12-M86 — Thermal Insulating and Finishing Cement
6. CAN/CGSB-51.53 — Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts
7. CGSB 51-GP-52Ma — Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.4 National Fire Protection Association (NFPA):

1. NFPA 255 — Standard Method of Test of Surface Burning Characteristics of Building Materials

.5 Thermal Insulation Association of Canada (TIAC)

.1 Mechanical Insulation Best Practices Guide.

.6 Underwriters Laboratories Canada (ULC)

1. CAN/ULC-S102 — Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
2. CAN/ULC-S701 — Thermal Insulation, Polystyrene, Boards and Pipe

1.3 Related Work Specified in Other Sections

.1 For complete plumbing insulation requirements refer to Section 23 07 00 – HVAC Insulation.

2. Products

.1 For complete plumbing insulation requirements refer to Section 23 07 00 – HVAC Insulation.

3. Execution

.1 For complete plumbing insulation requirements refer to Section 23 07 00 – HVAC Insulation.

END OF SECTION

1. General

1.1 Quality Assurance

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 Use fully qualified welders licensed by the provincial authorities and weld in accordance with the requirements of the Boiler Inspection Branch.

.4 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.5 For field welding, comply with the procedures of CSA-W55.2, CSA-W117.2-M87 and the ASME Standard for Power Piping currently in effect.

.6 Comply with the National Plumbing Code of Canada – 2010, Provincial Codes and Municipal Codes.

.7 For grooved pipe fitting systems, provide fittings and gaskets of same manufacturer throughout system.

.8 Non specified pipe joining and pipe fitting methods such as T-drill and Press Fit are not permitted in any piping system covered under Division 22.

1.2 Quality Assurance – Welding

.1 Use fully qualified welders licensed by the provincial authorities.

.2 For field welding, comply with the procedures of CSA W117.2-M87 “Code for Welding and Cutting (Requirements for Welding Operators)”.

.3 Use pressure welders for work on systems containing pressure in excess of 103.4 kPa (15 psig).

.4 Weld in accordance with the requirements of the Provincial Boiler Inspection Branch.

.5 Submit a statement describing welding procedures proposed for the review of the consultant before commencing work.

.6 Before proceeding with the welded joining on the entire piping system, prepare not more than ten sample joints for the on-site review by the consultant. The consultant may request the cutting out of one or more welding joints for close visual examination or x-ray test. Once the consultant has reviewed the samples, the remaining pipe welding joints shall be to the standard accepted.

.7 Welded joints shall be free of defects including: elongated slab, isolated slag, porosity, incomplete penetration, lack of fusion, burn-through, cracks, arc burn, internal concavity, hollow beads, internal undercuts, and external undercuts.

1.3 Reference Standards

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).

.1 ANSI/ASME B16.15 Cast Bronze Threaded Fittings, Classes 125 and 250.

.2 ANSI/ASME B16.18 Cast Copper Alloy Solder Joint Pressure Fittings.

.3 ANSI/ASME B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.4 ANSI/ASME B16.24 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 Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 ASTM B88M Standard Specification for Seamless Copper Water Tube (Metric).

.3 ASTM F492 Standard Specification for Propylene and Polypropylene (PP) Plastic-Lined Ferrous Metal Pipe and Fittings.

.3 American Water Works Association (AWWA).

.1 AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.4 Canadian Standards Association (CSA International).

.1 CSA B242 Groove and Shoulder Type Mechanical Pipe Couplings.

.5 Health Canada/Workplace Hazardous Materials Information System (WHMIS).

.1 Material Safety Data Sheets (MSDS).

.6 National Research Council (NRC)/Institute for Research in Construction.

.1 National Plumbing Code of Canada (NPC) 2010

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable Manufacturers

.1 Pipe and Fittings: Crane, Grinnell, Ladish, Taylor Forge.

.2 Plastic Pipe and Fittings: Building Products Orion, Emco, Domn-X, Scepter, Canplas.

.3 Grooved Piping Fittings: Victaulic.

2.2 Pipe and Fittings

Size	Material	Fitting	Joint
1. Domestic Water, Inside Building, Above Ground:			
All Sizes	ASTM B88 Type L, hard temper, copper tube	ANSI B16.22 capillary joint, cast brass or wrought copper	95-5 solder, brazed or rigid grooved mechanical with angle pattern bolt pad for pipes over 50mm (2”); cast brass - screwed
100 (4”) and above	Schedule 40, Type 304 S.S.	Heliarc welded, roll groove Type 304SS, to ASTM A-403	Welded
2. Domestic Hot Water Recirculation, Inside Building, Above Ground:			
All Sizes	ASTM B88 Type K, soft copper tube	ANSI B16.22 capillary joint, cast brass or wrought copper	95-5 solder, brazed; cast brass - screwed
3. Domestic Water Below Grade, Outside Building:			
75 (3”) and under	CSA B137.9, ASTM F128-1 Multi-purpose composite pressure pipe	No fittings	

Size	Material	Fitting	Joint
100 (4") and over	CSA CAN3-B137.3, AWWA C900, PVC, Class 150 (DR18)	Ductile iron	Flared tube and hub & spigot, uniflange connections required on all change-in-direction fittings

2.3 Unions and Flanges

.1 All other services, size 50mm and under: 1034 kPa malleable iron, bronze to iron ground joint unions for threaded ferrous piping, all bronze for copper piping. Unions to ANSI B16.3.

.2 Sizes 65mm and over: 1034 kPa forges steel slip-on flanges for ferrous piping, 1034 kPa bronze flanges for copper piping with gaskets. 1.59mm thick preformed synthetic rubber, compressed ARAMID/NBR (Durlon 8500). Gaskets to be rated for temperature and pressure of system. Flanges to ASTM A181, Grade 1. For 517 kPaG and higher, use Class 300. For all others, use Class 150.

2.4 Solder

.1 Generally, use 95-5 solder for pressure service, 50-50 solder for gravity drainage service.

2.5 Miscellaneous

.1 Use factory fabricated butt weld fittings for welded steel pipes.

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

3. Execution

3.1 Piping General

.1 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.2 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

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

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

.5 Use only eccentric reducing fittings. Top flat for water.

.6 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints. For grooved pipe system, use rigid couplings to prevent valve rotation.

.7 Sleeve all pipe passing through partitions, walls and floors.

.8 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.9 Ensure no contact between copper and ferrous metal.

.10 Provide drain valves at main shut-off valves, low points of piping and apparatus, and at the bottom of all risers.

.11 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.12 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.13 Provide for isolation of systems by section.

.14 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

.15 Use insulating plastic spacers for copper pipe installation in metal studs.

.16 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

3.2 Screwed Connections

.1 American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.

.2 Make screw joints metal to metal. Do not use lampwick or other packing material in making up screwed joints.

.3 Use Teflon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

.4 Thread chromium plated piping and make up carefully. Do not expose more than one full turn of thread beyond any fitting.

3.3 Welded Connections

.1 Prepare mating surfaces properly; at least one mating surface shall be beveled. Longitudinally align piping carefully, set 3.2mm space between mating surfaces and tack, using 6010 rod. Preheat the materials to be joined to at least 21°C (70°F). Make a minimum of three (3) passes; use 6010 rod for root pass, use 7018 rod for subsequent filler passes and final cover pass. Remove slag and flux after each pass by brushing or grinding. Remove voids from each pass by cutting or grinding and make good by back welding.

.2 Ensure complete penetration by the root pass. Measured at the inner diameter of the piping, the weld shall be a minimum of 1mm thicker than the pipe thickness.

.3 Do not caulk or pean welds.

3.4 Solder and Brazed Connections

.1 Remove burrs and chips and ream or file the pipe ends out to size or bore. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.

.2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.5 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 furring to a minimum.

.2 Slope water piping 0.2% and provide hose bibb drains at low points.

.3 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25mm (1”) dia or line size whichever is greater and 150mm (6”) high minimum. Square tees may only be used to assist with complete venting and draining.

3.6 Installation

.1 Bury outside water pipe minimum 2700 mm (9’-0”).

.2 Plumbing lines installed outside the building shall be separated by a minimum of 1 m (3’-0”) horizontally between the outside surfaces of the lines. The lines are not permitted to be stacked.

.3 Install piping material specified to 1.0m (3’-3”) outside of building or as noted on drawings.

.4 Water piping shall be complete from service connection to all fixtures, equipment, outlets, etc. Sizes of pipes shall be as shown or as specified.

.5 Exercise care in the laying of soft copper tubing that it does not bear or is in contact with rocks and that directional changes are gradual to ensure tubing will not be kinked or collapsed.

.6 Screw chromium plated piping.

.7 All brass and copper pipe and tubing shall be free from cuts, dents or other surface damage at the time of final inspection. Remove damaged pipe or tubing and replace with new pipe or tubing.

.8 Take branches from water supply mains from the top, bottom, or side, using crossover fittings where required by structural or operating conditions.

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

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

.11 Install piping material specified to 1.0m (3’-3”) outside of building or as noted on drawings.

3.7 Excavation and Backfilling

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for excavation and backfilling requirements.

END OF SECTION

1. General

1.1 Scope

.1 Water hammer arrestors

.2 Backflow preventers

.3 Vacuum breakers

.4 Pressure reducing valves

.5 Trap primers

.6 Meters

.7 Hose bibbs

.8 Water service connections

1.2 General Requirements

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

.2 Provide and include charges for connections to Municipal and Utility Company services, including costs to maintain temporary water supply pending acceptable water quality tests, where applicable.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Application and installation as required for water service shall be made and paid for by the Contractor.

.5 Every plumbing fixture is to be equipped with separate water line fixture stops at water connections to fixtures.

1.3 Standard References

.1 American Society for Testing and Materials International (ASTM)

.1	ASTM A126	Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
.2	ASTM B62	Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA)

.1 AWWA C700 — Cold Water Meters-Displacement Type, Bronze Main Case.

.2 AWWA C701 — Cold Water Meters-Turbine Type for Customer Service.

.3 AWWA C702-1 — Cold Water Meters-Compound Type.

.3 Canadian Standards Association (CSA International)

.1 CSA-B64 Series — Backflow Preventers and Vacuum Breakers.

.2 CSA-B356 — Water Pressure Reducing Valves for Domestic Water Supply Systems.

.4 National Research Council (NRC)/Institute for Research in Construction.

.1 National Plumbing Code of Canada (NPC) 2010

.5 Plumbing and Drainage Institute (PDI)

.1 PDI-WH201 — Water Hammer Arresters Standard.

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Submittals

.1 Provide shop drawings for the equipment noted below. Clearly identify model number and any options selected.

2. Products

2.1 Acceptable Manufacturers

.1	Water Hammer Arrestors	:	Jay R. Smith, Watts, Zurn.
.2	Backflow Preventers	:	Conbraco, Febco, Hersey, Watts, Wilkins, Zurn
.3	Vacuum Breakers	:	Febco, Watts.
.4	Pressure Reducing Valves	:	Conbraco, Febco, Watts, Wilkins.
.5	Trap Primers	:	Jay R. Smith, Watts, Zurn

.6 Hose Bibbs : Jay R. Smith, Watts, Zurn

2.2 Water Hammer Arrestors

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20mm (¾") minimum, and minimum 450mm (18") long.

.2 Provide stainless steel bellows or piston type water hammer arrestors on water lines connected to solenoid valves, flush valves and to fixture or group of fixtures complete with accessible isolation valve. Water hammer arrestors to be Zurn Z-1700 (bellows) or Z-1705 (piston) or equal.

Standard of Acceptance: Zurn Z-1700 (bellows)

Standard of Acceptance: Zurn Z-1705 (piston)

2.3 Backflow Preventers

.1 Construct to AWWA requirements complete with test cock as required and service repair kits.

.2 High Hazard: Reduced Pressure Principle Type: For 20mm (3/4") to 50mm (2") bronze body, celcon check seats, stainless steel relief valve seats, shafts and flange bolts, bronze body ball valve test cocks, bronze strainer, quarter turn bronze isolating ball valves. Reference standard CSA B.64.4.

Standard of Acceptance: Watts Series 909QT-S

.3 High Hazard: Reduced Pressure Principle Type: For 65mm and up, epoxy coated cast iron body, bronze seating and relief valve, stainless steel trim, bronze body ball valve test cocks, epoxy coated strainer, quarter turn isolating ball valves. Reference standard CSA B.64.4.

Standard of Acceptance: Watts 909OSY-S

.4 Low Hazard: Double Check Valve Assembly: For 20mm to 50mm bronze body, celcon check seats, stainless steel trim rubber disks, bronze ball valve test cocks, bronze strainer, quarter turn bronze isolating ball valves. Reference standard CSA B.64.5.

Standard of Acceptance: Watts 007

.5 Low Hazard: Double Check Valve Assembly: For 65mm and up, epoxy coated cast iron body, bronze seats, stainless steel trim, bronze body ball valve test cocks, epoxy coated strainer, quarter turn isolating ball valves. Reference standard CSA B.64.5. For sprinkler service, back-flow preventers to be UL/FM approved with UL/FM resilient seated OS&Y gate valves.

Standard of Acceptance: Watts 709OSY-S-FDA.

2.4 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards.

Standard of Acceptance: Watts No. 800M4QT

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions.

Standard of Acceptance: Watts No. 288A

Standard of Acceptance: Watts No. 388ASC (for bottom inlet and outlet)

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable.

Standard of Acceptance: Watts No. 8A

Standard of Acceptance: Watts No. NF8 (use for freezing conditions)

2.5 Pressure Reducing Valves

.1 25mm (1”) and Smaller: Bronze body, stainless steel integral strainer, high temperature rated diaphragm suitable for hot or cold water. Rated at maximum inlet pressure of 2758 kPa (400 psi), minimum reduced pressure 175 kPa (25 psi), maximum temperature 82°C (180°F).

Standard of Acceptance: Watts Series N45B-M1

.2 30 mm (1¼”) and Larger: Bronze body, stainless steel integral strainer, high temperature rated diaphragm suitable for hot or cold water, threaded ends to 50 mm (2”), flanged ends 65 mm (2½”) and larger. Rated at maximum inlet pressure of 2758 kPa (400 psi), minimum reduced pressure 175 kPa (25 psi), maximum temperature 82°C (180°F).

Standard of Acceptance: Watts Series N45B

.3 Size to suit flow capacities and service.

2.6 Trap Seal Primers

.1 For single floor drains the trap primer shall be automatically activated complete with vacuum breaker; connected to nearest cold water line and piped to traps. Provide access door for concealed installations.

Standard of Acceptance: Zurn 1022

.2 For multiple floor drains the trap primer shall be an electronic trap primer. The trap primer shall be complete with galvanized steel combination surface or recessed mount box and cover; 15mm (1/2”) solder copper inlet connection; brass ball type stop valve; slow closing 24 VAC solenoid valve with integral strainer; 120-24 VAC transformer; brass atmospheric vacuum breaker, PEDX water way and anti-scaling multi-port manifold with five (5) 15mm (1/2”) male PEX outlet connections. Provide access door for concealed installations.

Standard of Acceptance: Zurn Z1020

2.7 Meters

.1 Incoming Water Service Meter: Provide meter(s) to the requirements of the local municipality.

.2 Each meter station and remote reader wheel required shall be to local municipality requirements using meter manifold to owner’s requirements. Meters shall be required for full range of flow.

2.8 Hose Bibbs

.1 Refer to Plumbing Fixture Schedule on drawings for hose bibb types.

3. Execution

3.1 Installation

.1 Bury outside water pipe minimum 2700 mm (9’-0”).

.2 Plumbing lines installed outside the building shall be separated by a minimum of 1 m (3’-0”) horizontally between the outside surfaces of the lines. The lines are not permitted to be stacked.

.3 Install approved backflow preventer or vacuum breaker assemblies on water lines where contamination of domestic water may occur. Generally necessary on boiler make-up lines, sprinkler mains, hose bibbs and flush valves and where required by the authority having jurisdiction.

.4 Install vacuum breakers on any tank subject to back-siphonage.

.5 Install trap primers on all floor drains.

.6 Install pressure reducing valves to limit maximum static pressure at plumbing fixtures to 550 kPa (80 psi) or to the rated maximum operating pressure of the devices downstream, whichever is lower.

.7 Reduced pressure backflow preventers shall be mounted in easily serviceable locations within reach from an 1800 mm (72”) ladder. (ie. in mechanical room. Not in ceiling spaces.)

.8 All reduced pressure backflow preventers shall be provided with daylight type drainage or full flow piping drain line or sump.

.9 Reduced pressure backflow preventers to be mounted in the horizontal position. Double checks can be in horizontal or vertical, depending on manufacturers installation instructions.

.10 Do not run any wet piping through electrical machine rooms or other similar rooms.

.11 Coordinate fixture carrier requirements with architectural features and drawing requirements.

3.2 Backflow Preventer Assemblies

.1 Install line size reduced pressure backflow preventer on each water supply to the project.

.2 Provide an air gap funnel floor drain under each reduced pressure backflow preventer. Pipe drain to sanitary sewer.

.3 Test and verify all backflow preventer assemblies in accordance with the requirements of authorities having jurisdiction. Provide certification sheets for insertion in O & M manuals.

3.3 Vacuum Breakers

.1 Install vacuum breaker on all hose bibbs.

.2 Install vacuum breaker on water supplies to water closets, urinals, laundry sinks, mop sinks.

.3 Provide air gaps on all atmospheric drains such as drains from coils, blowdowns, tanks, equipment, riser drains, and relief valve discharge.

3.4 Service Connection

.1 Obtain from the Consultant mechanical site plans approved by the City prior to commencing work. Allow two weeks lead time for the City's processing time if mechanical site plans have not been previously approved.

.2 Provide new water service complete with valves, backflow preventers, water meter and by-pass valves. Provide reinforced concrete thrust blocks on underground water service piping as required.

.3 Provide new fire protection water service complete with rising stem isolation valves c/w tamper-switch.

.4 For services through basement walls provide sleeve in wall and bridging to undisturbed soil for service main and adequately support at wall with reinforced concrete bridge. Provide link seal between water pipe and wall sleeve. Securely anchor service main inside to concrete wall. For water service through floor at grade provide 1.3 mm (18 gauge) galvanized corrugated sheet metal sleeve around service main to 150 mm (6") above floor and 1800 mm (72”) minimum below grade. Size for minimum of 50 mm (2”) of loose fill insulation. Provide stainless steel restraining/clamp rods on vertical water service entry. Rods to be 19 mm (¾”) in minimum or as indicated on plans.

3.5 Excavation and Backfilling

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

END OF SECTION

1. General

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pumps controls where self-contained.

.3 Domestic water booster pump package.

.4 Accessories.

1.2 Quality Assurance

.1 Base mounted pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid operating temperatures and pressures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve. Motor capacity shall be adequately sized to prevent overloading throughout entire range of performance curve.

.3 The package pressure booster shall be hydraulically tested to 862 kPa (125.0 psig).

.4 The pump control panel shall be listed by and bear the label of Underwriter's Laboratory, Inc. (UL/cUL). The controller shall be specifically designed for pressure booster applications.

.5 The pumping package shall be certified by an approved independent testing and certification organization as being compliant with the requirements of NSF/ANSI 61 for potable drinking water and NSF-61 Annex G for low lead content.

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Submittals

.1 Submit pump shop drawings that include, at a minimum, the following:

- .1 Pump performance and efficiency curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.

.2 Pump construction including seals.

.3 Dimensions and recommended installation.

.4 Wiring and schematic diagrams.

.2 Submit domestic water booster package shop drawings that include, at a minimum, the following:

.1 System summary sheet

.2 Sequence of operation

.3 Shop drawing indicating dimensions, required clearances and location and size of each field connection

.4 Power and control wiring diagrams

.5 System profile analysis including pump curves and system curve

.6 Pump data sheets

2. Products

2.1 Acceptable Manufacturers

1.	In-line Circulator (Horizontal)	:	Armstrong, Bell & Gossett, Grundfos, Taco, Wilo
2.	Domestic Water Booster Pump Package	:	Armstrong, Bell & Gossett, Grundfos, Taco, Wilo

2.2 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1750 rpm unless specified otherwise.

.4 Pump connections shall be flanged.

.5 All pump flanges to be complete with pressure gauge tappings.

.6 Supply pumps compatible with system fluid and correct temperature range.

2.3 In-Line Circulator

.1 Type: Centrifugal, single stage, in-line, close-coupled.

.2 Casing: Bronze, flanged suction and discharge..

.3 Impeller: Bronze.

.4 Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

.5 Seals: Mechanical

.6 Pressure Classification: 860 kPa (125 psi) or 1.5 times actual discharge working pressure, whichever is greater.

.7 Motor: Drip proof construction, resilient mounted oil lubricated journal bearings.

2.4 Domestic Water Booster Package

.1 General

.1 The pump package shall utilize 1 (simplex) stainless steel pump in conjunction with a variable speed pump controller. Appropriate check and shutoff valves, pressure sensors, suction/discharge piping, pump and electrical protection shall be integrated into the pump package. System connections shall be NPT for simplex systems.

.2 The packaged pumping system shall be constructed with Class 150 components for simplex. Unit shall be rated for 862 kPa (125.0 psig) working pressure and maximum temperature of 51.6°C (125ºF). Headers shall be easily removable to allow for service access and moving the package through doorways. The system shall start upon a drop in system pressure, and will regulate the speed of the pumps to maintain constant pressure under variable flow. The system will stop upon detection of no-flow.

.3 The entire package assembly shall be listed and bear the label of a nationally recognized test lab.

.4 System shall require a single point power connection.

.2 Pumps

.1 Pumps shall be constructed of 304 stainless steel and rated for a minimum 862 kPa (125.0 psig) working pressure.

.2 Casings shall have gauge ports and vent and drain ports at the top and bottom of casing. Pumps shall be centrifugal, closed-coupled end suction. Pump case, impellers, diffusers, seal spring, inner bowls, seal spring, shaft sleeve and retainer clip shall all be manufactured from stainless steel. Shaft bushing (if needed) shall be from ceramic. Mechanical seal assembly shall be constructed of Carbon/ Silicon Carbide/ Viton as standard. Seat elastomers and casing o-rings shall be from Viton. Shaft sleeve shall be from stainless steel.

.3 Pump connections shall be NPT or ANSI flanged.

.4 Pump shall accept a standard NEMA C-face motor or JM frame and shall not require a specialty motor with special thrust bearings or integrated VFD.

.5 Pumps shall have thrust balanced within the pump.

.6 Pump curve shall rise continuously to shut off head. Best efficiency point of pump shall lie between 70% and 80% of maximum flow capacity of the pump.

.3 Motors

.1 Motor(s) shall be C-face or JM frame type open drip proof or TEFC enclosures 1.15 service factor, Min class F insulation. Motors shall be wound for the starting configuration as called out in the technical data sheet.

.2 Design pump brake horsepower shall not exceed 100% of motor horsepower exclusive of service factor. The motor shaft shall be high-strength steel. Motors shall be wound with ISR (Inverter Spike Resistant) wire for use with VFD's. Motor manufacturer must provide letter of compatibility of motor with another type of variable frequency or variable speed drive.

.4 Variable Speed Drives

.1 The variable speed drive controller shall be rated NEMA 1 or 3R. A station disconnect switch shall be mounted in a NEMA 1 panel.

.2 The variable speed drive shall provide an adjustable carrier frequency with IGBT power switching, and utilize PWM technology.

.3 The drive shall provide noiseless operation of the driving motor, short circuit and ground protection, and work with controlled sinusoidal current synthesis and dynamic over current limitations.

.4 Additional control panels, PLC's or other external devices, shall NOT be necessary to accomplish complete pump programming and variable speed control of pump and motor.

.5 Standard variable frequency drives that do not incorporate pump control logic as the primary control software; programming and features directly applicable to centrifugal pump applications shall not be considered equal.

.6 Standard system hydraulic settings shall include at a minimum the following functions:

.1 Loss of suction

.2 Lack of NPSHa

.3 Pump run-out protection

.4 "Dead-head" protection

.5 Constant pressure setting with variable flow capability

.6 Pressure sensor error

.7 Overpressure shutdown

.8 Low flow shutdown.

.5 Pump Package Base

.1 The pump package base shall be designed and fabricated to provide proper structural support for all attached equipment, and provide anchor bolt support. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off-loading, installation, and operation.

.2 The base shall be constructed from 0.3 in formed steel. Provisions shall be made in the station base for off-loading and handling the station at the site of installation. Formed base shall include steel plate mounted under pump and motor and shall be of compact design for most standard doorways.

.6 Piping

.1 Type L - Copper headers for duplex units and Class 150 components for simplex. Suction and Discharge manifolds shall be designed and constructed for minimal friction loss and compact design for most standard doorways.

.7 Valves

.1 Isolation valves shall be provided for each pump for duplex units only. Each pump shall be equipped with a spring-loaded non-slam silent check valve, appropriately sized to allow no greater than 34.5 kPa (5.0 psig) of head loss at full station rated capacity.

.2 Check valves 50mm (2.0”) and below shall have a brass body and PTFE Teflon seat. Check valves 50mm (2.0”) and below shall be pressure rated to 2758 kPa (400.0 psig) WOG. The operation of the valve shall not be affected by the position of installation. When pump is retired, valve shall function to close tightly before flow is reversed, and reducing the possibility of water hammer or shock.

.8 Paint

.1 The finish coat shall be acrylic enamel to a thickness of no less than 3 mils.

.9 Ship Loose Items

.1 Low Suction Pressure Cut-out Switch; range: 68.9-689 kPa (10-100 psig).

.10 Sequence of Operation

.1 The system shall start upon a drop in system pressure, and will regulate the speed of the pumps to maintain constant pressure under variable flow. The system will stop upon detection of no-flow.

3. Execution

3.1 Installation

.1 Install pumps in accordance with manufacturer’s requirements.

.2 Provide mounting supports on piping. Piping is not to be supported off pump flanges. Support in-line pumps at intake and discharge and motor as per manufacturer’s recommendations.

.3 Provide drains for bases piped to and discharging into floor drains.

.4 Provide air cock and drain connection on horizontal pump casings.

.5 Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and plug cock balancing valve on discharge.

.6 Check motor and pump lubrication points, fill oil reservoir on in-line of pumps.

.7 Provide complete vibration isolation for assemblies including suction and discharge piping.

.8 At all in-line pump assemblies, provide flexible pipe connections at inlet and outlet to pumps. Substitution of flexible pipe connections with flexible pipe connector gasket/clamp assemblies (Victaulic or equal) will be considered. Install in accordance with manufacturer’s recommendations.

.9 Provide vibration isolated pipe hangers (resilient support) next to pumps on piping. Refer to section 23 05 48.

.10 Decrease from suction line size with eccentric reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Support suction guide and discharge elbow from a floor stand with rubber and shear sandwich pad isolators or from above with hangers and spring isolators.

.11 Control wiring for remote mounted switches and sensor / transmitters, serving the domestic water booster package, shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.

3.2 Field Quality Control

.1 Test pumps and systems to verify capacity, sequence of operation and flow.

.2 Trim pump impellers to meet actual field conditions.

3.3 Demonstration & Training

.1 The system manufacturer's factory qualified representative shall be capable of providing optional start-up of the packaged pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This job site visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.

.2 The system manufacturer's factory qualified representative shall be capable of providing on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.

.3 The system manufacturer must have an optional complete pressure booster training program available for owner's personnel. The training sessions shall take place at the manufacturer's facility and cover all aspects of pressure booster system design, service and operation.

3.4 Performance

.1 Refer to Pump Schedule on drawings.

END OF SECTION

1. General

1.1 Quality Assurance

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Comply with the National Plumbing Code of Canada – 2010, Provincial Codes and Municipal Codes.

1.2 Reference Standards

.1 American Society for Testing and Materials International, (ASTM).

.1	ASTM B32	Specification for Solder Metal.
.2	ASTM B306	Specification for Copper Drainage Tube (DWV).
.3	ASTM C564	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
.4	ASTM D2235	Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.5	ASTM D2564	Specifications for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International).

.1	CSA B67	Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
.2	CAN/CSA-B70	Cast Iron Soil Pipe, Fittings and Means of Joining.
.3	CAN/CSA-B125	Plumbing Fittings.
.4	CSA-Series B1800	Plastic Nonpressure Pipe Compendium.
.5	CSA-B181.2	PVC Drain, Waste and Vent Pipe and Pipe Fittings.

.6 CSA-B182.1 Plastic Drain and Sewer Pipe and Pipe Fittings.

.3 National Research Council (NRC)/Institute for Research in Construction.

.1 National Plumbing Code of Canada (NPC) 2010

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Acceptable Manufacturers

.1 Pipe and Fittings: Crane, Grinnell, Ladish, Taylor Forge.

.2 Plastic Pipe and Fittings: Building Products Orion, IPEX, Emco, Domn-X, Scepter, Canplas.

2.2 Pipe and Fittings

Size	**Material**	**Fittings**	**Joint**
1. Sanitary, Waste and Vent Piping Above Grade (Inside Building):			
65 (2½”) and smaller	ASTM B306 DWV grade hard temper copper tube	ANSI B16.29 cast brass or wrought copper	Soldered 50-50
75 (3”) and larger	CSA.B70,27580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, factory applied corrosion resistant coating inside and out	Mechanical joint, Hub & Spigot
2. Sanitary, Waste and Vent Piping Below Grade (Inside Building):			
All sizes	CSA.B70, 27580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, with a heavy bituminous coating	Mechanical joint, Hub & Spigot
150 (6”) and smaller	ABS-DWV to CSA B181.1 - 1973	ABS	Solvent cement

Size	Material	Fittings	Joint
150 (6”) and smaller	PVC, DWV to CSA B181.2 - 1973	PVC	PVC solvent cement, solvent weld
200 (8”) and larger	PVC, SDR35	PVC	PVC solvent cement
3. Sanitary and Waste Piping Below Grade (Outside Building):			
100 – 150 (4” – 6”)	ABS-DWV to CSA B181.1 - 1973	ABS	Solvent cement
100 - 150 (4” – 6”)	PVC, DWV to CSA B181.2 - 1973	PVC	Solvent weld
200 - 375 (8” – 15”)	PVC, SDR35 to CSA B181.1 – 1973, B182.2 - 1973	PVC	Gasketted hub & spigot
450 (18”) and larger	PVC, R16 reinforced to CSA B182.4-M1983 Canron “Perma-Loc” or IPEX “Ultra-rib”		Gasketted hub & spigot

2.3 Solder

.1 Generally, use 95-5 solder for pressure service, 50-50 solder for gravity drainage service.

2.4 Couplings

.1 Hubless couplings shall be composed of a stainless steel shield, clamp assembly and elastomeric sealing sleeves to CSA-B602 and CAN/ULC-S102.

3. Execution

3.1 Piping General

.1 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.2 Clamp cast iron water pipe at fittings with 20mm (¾”) rods and properly anchor and support.

.3 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.4 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

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

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

.7 Use only eccentric reducing fittings.

.8 Sleeve all pipe passing through partitions, walls and floors.

.9 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.10 Ensure no contact between copper and ferrous metal.

.11 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.12 Do not run piping carrying liquids over electrical switchboards, elevator controllers or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.13 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

.14 Install and support piping so that strain and weight does not bear on cast iron fittings or apparatus.

.15 Mechanical contractor is to provide pictures of underground services to the mechanical engineer a minimum of one (1) week prior to the services being backfilled.

.16 Underground piping installed below structural slabs is to be supported by pipe hangers hung from the structure.

3.2 Solder and Brazed Connections

.1 Remove burrs and chips and ream or file the pipe ends out to size or bore. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.

.2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.3 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 furring to a minimum.

.2 Grade horizontal drainage and vent piping 2% minimum.

.3 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blow downs, water columns, and overflows to the nearest building drain.

3.4 Installation

.1 Bury outside drainage pipe minimum 2400mm (8’-0”).

.2 Plumbing lines installed outside the building shall be separated by a minimum of 1m (3’-0”) horizontally between the outside surface of the lines. The lines are not permitted to be stacked.

.3 Install piping material specified to 1.0m (3’-0”) outside of building or as noted on drawings.

.4 Run pipes in straight lines and have a uniform grade between elevations noted. No branch drain shall have a lesser grade than that indicated for the main drain to which it is connected. Where elevations are not given, pipes shall have a uniform grade of 6.5mm per 300mm, except that where such grade on overhead pipes would reduce the headroom materially, the grade may be reduced to not less than 3.2mm per 300mm, if so directed by the consultant. All overhead pipes must be kept as close to ceilings as possible, unless otherwise indicated or noted.

.5 Do not use double hubs, straight crosses, double T’s or double TY’s in any soil or waste pipe below any fixture. Do not install a branch fitting other than the full Y and an eight bend on any soil or waste pipe running in a horizontal plane. Quarter bends placed on their sides shall not be permitted. Do not use inverted joints below any fixture.

.6 Regardless of pipe and fitting materials specified in "Products" section of this specification section, All sanitary drainage piping within 10m (30’-0”) downstream of a sterilizer, relief valve or any device that may discharge fluid into the sanitary sewer above 60°C (140°F) shall be cast iron.

3.5 Excavation and Backfilling

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for excavation and backfilling requirements.

END OF SECTION

1. General

1.1 Scope

.1 Cleanouts

.2 Floor drains

.3 Oil Interceptor

.4 Sanitary sewer service connections

1.2 General Requirements

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

.2 Provide and include charges for connections to Municipal and Utility Company services.

.3 Non-ferrous metals are to be used in high humidity areas.

1.3 Standard References

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM A126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62 Specification for Composition Bronze or Ounce Metal Castings.

.2 Canadian Standards Association (CSA International)

.1 CSA-B79 Floor, Area and Shower Drains, and Cleanouts for Residential Construction.

.3 National Research Council (NRC)/Institute for Research in Construction.

.1 National Plumbing Code of Canada (NPC) 2010

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Submittals

.1 Provide shop drawings for the equipment noted below. Clearly identify model number and any options selected.

2. Products

2.1 Acceptable Manufacturers

.1 Cleanouts : Jay R. Smith, Mifab, Zurn, Watts.

.2 Floor Drains : Jay R. Smith, Mifab, Zurn, Watts.

2.2 Cleanouts and Cleanout Access Covers

.1 Supply and install cleanout on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where drains leave the building; where shown on the drawings; 7.6m (25 ft) apart in horizontal drainage lines of 50mm (2”) and 65mm (2-1/2”) nominal diameter; 15.2m (50 ft) apart in horizontal lines of 75mm (3”) or 100mm (4”) nominal diameter and not more than 26m (85 ft) for larger pipe sizes and as called for in the National Plumbing Code.

.2 All cleanouts shall be full size for pipes up to 100mm (4”) diameter and 100mm (4”) size of larger pipes. Cleanouts shall be extended to a finished wall or floor.

.3 Provide caulked or threaded type extended to finished floor or wall surface. Ensure ample clearance at cleanout for rodding of drainage system. The piping shall be extended beyond the room for cleanout installation. Where cleanouts occur in carpeted areas, they shall be extended to the finished walls unless the Consultant gives special permission for them to terminate in the carpeted floor.

.4 In potentially wet areas such as washrooms, cleanouts shall be extended to the walls wherever possible. Where conditions do not permit wall cleanouts, the cleanout cover shall be waterproof, with nickel bronze. frame and cover and with integral waterproofing clamping collar. All cleanouts passing through walls or floors with a waterproofing membrane shall have a clamping collar which shall be clamped to the membrane.

Standard of Acceptance: Zurn ZN-1602

.5 Cleanouts for copper pipe shall be cast brass with raised shoulder on plug and gasket.

.6 Cleanouts for cast iron pipe shall be steel plug type.

.7 Covers for cleanouts shall be as follows:

.1 Unfinished areas, such as concrete floors in equipment rooms and flush type cleanouts in outside areas:

Standard of Acceptance: Zurn ZXN-1612 with cover suitable for heavy traffic.

.2 Slab on grade finished in ceramic tile; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-Z

.3 Upper floors finished in ceramic tile; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-Z

.4 Floors finished in lino or other such thin material; cleanout to be complete with nickel bronze frame and cover:

Standard of Acceptance: Zurn ZN-1400-TX (square)

Standard of Acceptance: Zurn ZN-1400-X (round)

.5 Walls finished in ceramic tile; cleanout to be complete with nickel bronze frame and cover; 250mm x 250mm (10' x 10"):

Standard of Acceptance: Zurn ZN-1443-TX

.6 All painted walls, provide prime coated covers as specified for access panels with minimum clear opening of 200mm x 200mm (8"x8") for cleanouts 50mm (2") and smaller; 300mm x 300mm (12" x 12" for cleanouts larger than 50mm (2"). Avoid covers on feature walls; ie: wood panels. If unavoidable, the covers shall be for painted walls but with finish material secured to the cover to the satisfaction of the Consultant and finished flush with wall. In all sterile areas provide stainless steel finish on all access panels. All cleanouts have locations clearly indicated.

Standard of Acceptance: Acudor UF-5000

Standard of Acceptance: Acudor FB-5060 (fire rated).

.8 All barriers for cleanout plugs shall be securely anchored so that they do not rotate when the plug is being removed.

2.3 Floor Drains

.1 Flow Characteristics: Full open flow unless noted otherwise. Check all construction details prior to ordering drains and ensure the drains are suitable for the construction.

.2 Refer to Plumbing Fixture Schedule for floor drain types.

3. Execution

3.1 Installation

.1 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover, remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.

.2 Where floor drains are located over occupied areas, provide waterproof installations.

.3 Floor drains located in floating floors with no membrane provide lead flashing pan. 900mm x 900mm (36” x 36”) at 39 kg/m² (8lb/ft^2). Flash membrane or lead into flashing clamp on drain body.

.4 Install trap primers on all floor drains. Refer to Section 22 11 19, Domestic Water Piping Specialties. Primers shall be installed in an area accessible for easy maintenance.

.5 Plumbing vents shall be located minimum 5m (16’-0”) from air intakes.

.6 Do not run any wet piping through electrical rooms or other similar rooms.

.7 Provide dielectric fittings in all dissimilar metal connections.

.8 Coordinate type of floor drains specified with building construction details.

.9 Install cast iron connections from weeping tile to sanitary drainage system including backwater valve, deep seal P-trap and cleanout. Provide access for servicing of backwater valve.

3.2 Service Connection

.1 Obtain from Consultant mechanical site plans approved by City prior to commencing work. Allow two weeks lead time for the City’s processing time if mechanical site plans have not been previously approved.

.2 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.3 For services through basement walls provide sleeve in wall and bridging to undisturbed soil for service main and adequately support at wall with reinforced concrete bridge. Provide link seal between water pipe and wall sleeve. Securely anchor service main inside to concrete wall.

END OF SECTION

1. General

1.1 Quality Assurance General

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Comply with the National Plumbing Code of Canada – 2010, Provincial Codes and Municipal Codes.

1.2 Reference Standards

.1 American Society for Testing and Materials International, (ASTM)

.1	ASTM B32	Specification for Solder Metal.
.2	ASTM B306	Specification for Copper Drainage Tube (DWV).
.3	ASTM C564	Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
.4	ASTM D2235	Specification for Solvent Cement for Acrylonitrille-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
.5	ASTM D2564	Specifications for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.

.2 Canadian Standards Association (CSA International)

.1	CSA B67	Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
.2	CAN/CSA-B70	Cast Iron Soil Pipe, Fittings and Means of Joining.
.3	CAN/CSA-B125	Plumbing Fittings.
.4	CSA-Series B1800	Plastic Nonpressure Pipe Compendium.
.5	CSA-B181.2	PVC Drain, Waste and Vent Pipe and Pipe Fittings.

.6 CSA-B182.1 Plastic Drain and Sewer Pipe and Pipe Fittings.

.3 National Research Council (NRC)/Institute for Research in Construction

.1 National Plumbing Code of Canada (NPC) 2010

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable Manufacturers

.1 Pipe and Fittings : Charlotte Pipe, Crane, Ladish, Taylor Forge

.2 Plastic Pipe and Fittings : Canplas, Charlotte Pipe, IPEX, Orion

2.2 Pipe and Fittings

Size	Material	Fittings	Joint
.1 Storm Piping Above Grade (Inside Building)			
75 (3”) and larger	CSA B70, 27,580 kPa crushing strength, cast iron with varnish asphalt base	Cast iron, CSA B70, factory applied corrosion resistant coating inside and out	Mechanical joint, Hub & Spigot
.2 Storm Piping Below Grade (Inside Building)			
All sizes	CSA B70, 27,580 kPa crushing strength, cast iron with varnish asphalt base. Provide cast iron for mechanical room floor drainage	Cast iron, CSA B70, with a heavy bituminous coating	Mechanical joint, Hub & Spigot
150 (6”) and smaller	ABS-DWV to CSA B181.1 – 1973	ABS	Solvent cement
150 (6”) and smaller	PVC, DWV to CSA B181.2 – 1973	PVC	PVC solvent cement, solvent weld

200 (8") and larger	PVC, SDR35	PVC	PVC solvent cement
.3 Storm Piping Below Grade (Outside Building)			
100 – 150 (4" – 6")	ABS-DWV to CSA B181.1 - 1973	ABS	Solvent Cement
100 -150 (4" – 6")	PVC, DWV to CSA B181.2 - 1973	PVC	Solvent Weld
200 – 375 (8" – 15")	PVC, SDR35 to CSA B181.1 – 1973, B182.2 - 1973	PVC	Gasketted Hub & Spigot
450 (18") and larger	PVC, R16 reinforced to CSA B182.4-M 1983 Canron "Perma-Loc" or IPEX "Ultra-rib"		Gasketted Hub & Spigot

2.3 Couplings

.1 Hubless couplings shall be composed of a stainless steel shield, clamp assembly and elastomeric sealing sleeves to CSA-B602 and CAN/ULC-S102.

3. Execution

3.1 Piping General

.1 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.2 Clamp cast iron water pipe at fittings with 20mm (¾") rods and properly anchor and support.

.3 Install and support piping so that strain and weight does not bear on cast iron fittings or apparatus.

.4 Install piping approximately as shown, with all lines being carried parallel to building walls, as close to the structure as possible, or as detailed on the drawings.

.5 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

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

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

.8 Use only eccentric reducing fittings

.9 Sleeve all pipe passing through partitions, walls and floors.

.10 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.11 Do not run piping carrying liquids over electrical switchboards or electrical motor starters. Where this is unavoidable, provide 1.2mm gauge aluminum pans under piping. Each drip pan shall have a drain piped to discharge over nearest available open drain. This does not apply in Mechanical Rooms.

.12 Ensure piping location does not subject piping to frost damage under flow or no-flow conditions.

.13 Mechanical contractor is to provide pictures of underground services to the mechanical engineer a minimum of one (1) week prior to the services being backfilled.

.14 Underground piping installed below structural slabs is to be supported by pipe hangers hung from the structure.

3.2 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 furring to a minimum.

.2 Grade horizontal drainage piping at 2% minimum unless indicated otherwise on drawings.

3.3 Installation

.1 Bury outside drainage pipe minimum 2400mm (8’-0”).

.2 Plumbing lines installed outside the building shall be separated by a minimum of 1m (3’-0”) horizontally between the outside surface of the lines. The lines are not permitted to be stacked.

.3 Install piping material specified to 1.0m (3’-3”) outside of building or as noted on drawings.

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

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

.6 Install piping material specified as inside the building to 3m (10’-0”) outside of building.

.7 Run pipes in straight lines and have a uniform grade between elevations noted. No branch drain shall have a lesser grade than that indicated for the main drain to which it is connected. Where elevations are not given, pipes shall have a uniform grade of 6.5mm per 300mm, except that where such grade on overhead pipes would reduce the headroom materially, the grade may be reduced to not less than 3.2mm per 300mm, if so directed by the consultant. All overhead pipes must be kept as close to structure as possible, unless otherwise indicated or noted.

3.4 Excavation and Backfilling

.1 Refer to Section 23 05 00 – Common Work Results for HVAC for excavation and backfilling requirements.

END OF SECTION

1. General

1.1 Scope

.1 Cleanouts

.2 Roof drains

1.2 General Requirements

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

.2 Provide and include charges for connections to Municipal and Utility Company services.

1.3 Standard References

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM A126 Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62 Specification for Composition Bronze or Ounce Metal Castings.

.2 National Research Council (NRC)/Institute for Research in Construction.

.1 National Plumbing Code of Canada (NPC) 2010

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Submittals

.1 Provide shop drawings for the equipment noted below. Clearly identify model number and any options selected.

2. Products

2.1 Acceptable Manufacturers

.1 Cleanouts : JR Smith, Mifab, Watts, Zurn.

.2 Roof Drains : JR Smith, Mifab, Watts, Zurn.

2.2 Cleanouts and Cleanout Access Covers

.1 Supply and install cleanouts on all drains at all changes in direction, at the ends of all horizontal runs, at the base of every stack where a drain leaves the building; where shown on the drawings, 7.6 meters (25 feet) apart in horizontal drainage lines of 50mm (2”) and 65mm (2½”) nominal diameter, 15.2 meters (50 feet) apart in horizontal lines of 75mm (3”) or 100mm (4”) nominal diameter and not more than 26 meters (85 feet) apart for larger pipe sizes and as called for in the National Plumbing Code.

.2 All outside cleanouts shall be extended to grade in cast iron. They shall be sufficiently anchored in a 300mm x 300mm x 100mm (12”x12”x4”) thick concrete block of concrete to prevent rotation of the pipe. Concrete work shall be provided and installed by the General Contractor.

.3 All cleanouts shall be full size for pipes up to 100mm (4”) diameter and 100mm (4”) size for larger pipes. Cleanouts shall be extended to a finished wall or floor. Cleanouts shall not terminate in the floor of any sterile rooms.

.4 Cleanouts for cast iron pipe shall be steel plug type, Associated Foundry.

.5 Cleanouts for weeping tile shall be epoxy coated cast iron with epoxy coated ductile iron gasketed cover, vandal proof; suitable for installation on cast iron, PVC or ABS pipe.

Standard of Acceptance: Watts CO-200-4-6

.6 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted cover plate cleanouts on vertical rainwater leaders only. Ensure ample clearance at cleanout for rodding of drainage system.

.7 Floor cleanout access covers in unfinished areas shall be epoxy coated cast iron body, adjustable heavy duty round nickel bronze cover suitable for heavy traffic. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

Standard of Acceptance: Watts CO-200-RX-1

2.3 Roof Drains

.1 Material: All major components including body, flashing clamping flange, under deck clamp dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanized. Dome may be rigid secured plastic where specified or prior approval and shall be a natural color such as black or grey.

.2 Roof drains shall be with underdeck clamp and extension collars as required to suit roof construction. This contractor shall verify roof construction details and order roof drains accordingly at no additional cost to the contract.

.3 All drains shall be reviewed and accepted by the roofing inspector prior to ordering.

.4 Flow Characteristics: Full open flow.

.5 Roof drains shall have lacquered cast iron body with large gravel sump, removable cast metal mushroom dome (or deck) strainer, flashing flange and flashing clamp with integral gravel stop

.6 Refer to Plumbing Fixture Schedule on drawings for roof drain types.

.7 Parapet drains shall have polished brass sloping grate.

3. Execution

3.1 Installation

.1 Lubricate cleanout plugs with mixture of graphite and linseed oil. Prior to building turnover, remove cleanout plugs, re-lubricate and re-install using only enough force to ensure permanent leakproof joint.

.2 Install roof drains with 800mm x 800mm (32” x 32”) at 39kg/m² (8 lb/ft2) sheet lead.

.3 Do not run any wet piping through electrical machine rooms or other similar rooms.

.4 Provide dielectric fitting in all dissimilar metal connections.

.5 Coordinate types of drains specified with building construction details.

END OF SECTION

1. General

1.1 Scope

.1 Natural gas fired domestic water heaters

.2 Accessories

1.2 Quality Assurance

.1 Domestic water heaters to conform with all local and provincial requirements.

.2 Natural gas fired units to bear ULC label.

1.3 Reference Standards

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

.2 American Society of Mechanical Engineers (ASME)

.1 ASME Section IV – Heating Boilers

.3 Canadian Gas Association (CGA)

.1 ANSI Z21.10.1/CSA 4.1 Gas Water Heaters - Volume I, Storage Water Heaters With Input Ratings Below 75,000 Btu Per Hour.

.2 ANSI Z21.10.3/CSA 4.3 Gas Water Heaters - Volume III - Storage Water Heaters, with Input Ratings Above 75,000 Btu Per Hour.

.3 CSA-B149.1 Natural Gas and Propane Installation Code.

.4 Canadian Standards Association (CSA International)

.1 CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code.

1.4 Warranty

.1 Domestic water heater to have a minimum five (5) year limited warranty.

.2 Warranty shall begin on the date of installation.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

.1 Shop drawing shall include, at a minimum, the following:

.1 Performance data

.2 Storage capacity

.3 Recovery rate

.4 Efficiency ratings

.5 Dimension including locations and sizes of tappings

.6 Electrical data

.2 Include confirmation of approvals from relevant agencies including ANSI, CSA and ASHRAE.

.3 Include clearance requirements and breeching or stack configurations and materials.

2. Products

2.1 Acceptable Manufacturers

1. Commercial Domestic Water Heaters (Gas Fired) : A.O. Smith, Bock, Jetglass, Rheem, Lochinvar

2.2 Gas Fired Tank Type Domestic Water Heater

.1 Construction:

.1 Seamless glass lined steel tank.

.2 Natural gas fired down fired power burner.

.3 Boiler type hand hole cleanout.

.4 Glass-lined steel burners.

.5 Replaceable magnesium anode rods.

.6 External non-CFC foam insulation with heavy gauge steel jacket with baked enamel finish.

.7 Maximum working pressure 110 3kPaG (160 psig).

.8 Maximum working temperature 82°C (180°F).

.9 For units with input rating exceeding 58.6kW (200 MBH) or storage capacity is over 454L (120US gal), water heaters to be designed and constructed to ASME code requirements.

.2 Controls:

.1 Integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display and shall have digital temperature readout.

.2 Power on/off switch.

.3 Gas pressure regulator and pilot filter, manual reset gas shut-off valve.

.4 Adjustable thermostat 50°C-82°C (120°F-180°F) range. Set to 60°C (140°F).

.5 Low profile draft diverter with automatic motorized flue damper.

.6 Electrical: 120V/1Ph/60Hz.

.3 Accessories:

.1 CSA certified and ASME rated pressure and temperature relief valve.

.2 Domestic hot water heater is to be supplied complete with an acid neutralization tank and concentric vent kit.

3. Execution

3.1 Installation

.1 Install in complete accordance with manufacturers recommendations.

.2 Mount unit on 100mm (4”) thick concrete housekeeping pad. Ensure unit is installed level.

.3 Make natural gas connection to water heater complete with dirt pocket, shut-off cock and union.

.4 Make breeching or chimney connections to unit in accordance with current edition of CSA B149.1.

.5 Make domestic water connection to unit complete with dielectric unions and isolation valves.

.6 Extend relief valve discharge to floor.

3.2 Performance

.1 Refer to Domestic Water Heater Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

.1 Commercial plumbing fixtures and trim

1.2 Quality Assurances

.1 Provide new CSA approved plumbing fixtures and trim free from flaws and blemishes with finished surfaces clear, smooth and bright. Visible parts of fixture brass and accessories shall be heavily chrome plated.

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

.3 Vitreous china fixtures shall be white unless noted otherwise.

.4 Protect fixtures against use and damage during construction.

Laboratory Brass Trim

.5 Laboratory brass fittings shall be of one manufacturer, shall have corrosion resistant finish where specified and shall be color-coded and indexed.

.6 Laboratory water faucets with gooseneck spouts shall be protected by vacuum breakers meeting the requirements of ANSI Standard ANSI/ASSE 1001, Pipe Applied Atmospheric Type Vacuum Breakers.

1.3 Reference Standards

.1 Canadian Standards Association (CSA)

.1	CAN/CSA B45 Series-02	General Requirements for Plumbing Fixtures.
.2	CAN/CSA B125	Plumbing Fittings.
.3	CAN/CSA B651	Barrier Free Design.

.2 National Plumbing Code of Canada 2010

.3 Alberta Barrier-Free Design Guide

1.4 Job Conditions

.1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Advise consultant of discrepancies prior to ordering fixtures or trim.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

.1 Submit shop drawings for review. Shop drawings shall indicate, as a minimum, the following:

.1 Each sheet is clearly marked with fixture designation

.2 Operating characteristics (ie flow rates)

.3 Materials of construction

.4 Finishes

.5 Mounting requirements and rough-in dimensions

2. Products

2.1 Acceptable Manufacturers

.1	Electronic Faucets	:	Chicago Faucet, Delta, Kohler, Moen, Sloan, Symmons, Toto, Zurn
.2	Fixture Carriers	:	Jay R Smith, Mifab, Watts
.3	Flush Valves – Electronic	:	American Standard, Delta, Kohler, Moen, Sloan, Toto, Zurn
.4	Flush Valves – Manual	:	Delta, Kohler, Sloan, Toto, Zurn
.5	Lavatories	:	American Standard, Crane, Kohler
.6	Manual Faucets	:	Chicago Faucet, Delta, Kohler, Moen, Sloan, Symmons, Toto, Zurn
.7	Mop Sinks	:	Crane, Fiat, Stern-Williams, Zurn
.8	Plumbing Brass	:	American Standard, Chicago Faucet, Delta, Moen, Kohler, Symmons, Zurn
.9	Stainless Steel Sinks	:	Blanco, Franke, Kindred, Elkay
.10	Water Closets and Urinals	:	American Standard, Crane, Kohler, Toto
.11	Thermostatic Mixing Valves & Pressure Balancing Valves	:	American Standard, Chicago Faucet, Delta, Kohler, Moen, Symmons, Zurn

.12 Toilet Seats : American Standard, Kohler, Olsonite, Toto

2.2 Lavatories

.1 Refer to Plumbing Fixture Schedule on drawings for lavatory types.

2.3 Mop Sinks

.1 Refer to Plumbing Fixture Schedule on drawings for mop sink types.

2.4 Sinks

.1 Refer to Plumbing Fixture Schedule on drawings for sink types.

2.5 Showers

.1 Refer to Plumbing Fixture Schedule on drawings for shower types.

2.6 Thermostatic Mixing Valves

.1 Refer to Plumbing Fixture Schedule on drawings for thermostatic mixing valve types.

2.7 Urinal

.1 Refer to Plumbing Fixture Schedule on drawings for urinal types.

2.8 Water Closet

.1 Refer to Plumbing Fixture Schedule on drawings for water closet types.

3. **Execution**

3.1 Installation

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

.2 Provide chrome plated rigid escutcheons at wall with flexible risers or supplies to fixtures with screwdriver stops, reducers and escutcheons.

.3 Install wall mounted urinals and water closets with approved wall carriers.

.4 Provide silicon caulking between finished walls and horizontal surfaces of water closets, and urinals. Sealant shall be a continuous smooth with a beveled water shed, sealant shall be mildew/algae resistant.

.5 Provide pressure reducing valves on water lines to fixtures which are not rated for the system operating pressures.

.6 Solidly attach floor mounted water closets to floor with lag screws.

.7 All toilets shall be complete with flange, wax seal, bolt caps, etc.

.8 Provide hangers to support all p-traps which are larger than 50mm (2”) in size.

.9 Sinks shall not be used to clean paint brushes, trowels, etc. Do not dispose construction waste down any plumbing fixtures.

.10 All mixing valves shall come with check stops.

.11 All trim and plumbing fixtures shall be located as per the Architectural Details.

3.2 Fixtures Rough-In Schedule

.1 Mount fixtures the following heights above finished floor:

Water Closets	
Standard	375 mm (15”) to top of bowl rim
Handicapped	450 mm (18”) to top of seat
Water Closet Flush Valves	
Standard	275 mm (11”) minimum above bowl rim
Handicapped	250 mm (10”) minimum above bowl rim
Urinal	
Standard	550 mm (22”) to top of bowl rim
Handicapped	500 mm (20”) to top of bowl rim

END OF SECTION

1. General

1.1 Scope

.1 Emergency eye/face wash units

.2 Emergency mixing valves

1.2 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.

1.3 Job Conditions

.1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Advise consultant of discrepancies prior to ordering fixtures or trim.

1.4 Submittals

.1 Submit shop drawings for review.

2. Products

2.1 Acceptable Manufacturers

1. Emergency Eye/Face Wash Units : Bradley
2. Emergency Mixing Valves : Bradley

2.2 Emergency Eye / Face Wash Units

.1 Refer to Plumbing Fixture Schedule for emergency eye/face wash unit types.

2.3 Emergency Mixing Valves

.1 Refer to Plumbing Fixture Schedule for emergency mixing valve types.

3. Execution

3.1 Installation

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

.2 Provide chrome plated rigid or flexible supplies to fixtures with screw driver stops, reducers and escutcheons.

.3 Provide pressure reducing valves on water lines to fixtures which are not rated for the system operating pressures.

.4 All trim and plumbing fixtures shall be located as per the Architectural Details.

END OF SECTION

1. General

1.1 Scope

.1 Security plumbing fixtures and trim.

1.2 Quality Assurances

.1 Provide new CSA approved plumbing fixtures and trim free from flaws and blemishes with finished surfaces clear, smooth and bright. Visible parts of fixture brass and accessories shall be heavily chrome plated.

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

.3 Protect fixtures against use and damage during construction.

1.3 Reference Standards

.1 Canadian Standards Association (CSA)

.1	CAN/CSA B45 Series-02	General Requirements for Plumbing Fixtures.
.2	CAN/CSA B125	Plumbing Fittings.
.3	CAN/CSA B651	Barrier Free Design.

.2 National Plumbing Code of Canada 2010

.3 Alberta Barrier-Free Design Guide

1.4 Job Conditions

.1 Check millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation. Advise consultant of discrepancies prior to ordering fixtures or trim.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

.1 Submit shop drawings for review. Shop drawings shall indicate, as a minimum, the following:

.1 Each sheet is clearly marked with fixture designation

.2 Operating characteristics (ie flow rates)

.3 Materials of construction

.4 Finishes

.5 Mounting requirements and rough-in dimensions

2. Products

2.1 Acceptable Manufacturers

1.	Security Showers		Acorn, Willoughby
2.	Security Toilet/Lavatory Combos	:	Acorn, Willoughby

2.2 Security Showers

.1 Refer to Plumbing Fixture Schedule on drawings for security shower types.

2.3 Security Toilet/Lavatory Combos

.1 Refer to Plumbing Fixture Schedule on drawings for security toilet/lavatory combo types.

3. Execution

3.1 Installation

.1 Connect fixtures complete with specified trim, supplies, drains accessory piping, vented traps, stops or valves, reducers, escutcheons and fittings for the proper installation of all fixtures and their respective supply fittings.

.2 Provide necessary hangers, supports, brackets, reinforcement, steel back-up plates and floor flanges to set fixtures level and square. Mount fixtures so that 90 kilogram (200 pound) mass will not loosen or distort mounting.

.3 At completion thoroughly clean plumbing fixtures and equipment.

3.2 Water Hammer Arrestors

.1 Provide water hammer arrestors or shock absorbers on fixtures with flush valves and/or quick closing valves.

3.3 Adjusting

.1 Adjustments:

.1 Adjust water flow rate to design flow rates.

.2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.

.2 Checks:

.1 Aerators: operation, cleanliness.

.2 Vacuum breakers, backflow preventers: operation under all conditions.

.3 Thermostatic controls:

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

.2 Unless otherwise noted set mixing valve temperature to 40°C (104°F).

END OF SECTION

1. General

1.1 Scope

.1 This contractor shall be responsible for and ensure that all ductwork is internally clean when handed over to the Owner. This responsibility includes the entire system, from outdoor air intakes to air terminals and from air terminal to relief outlets. It includes all ductwork, lined and unlined, all plenums and all equipment within or connected to ducts and plenums.

.2 The surfaces shall be considered clean when all foreign materials capable of particulating and visible to the naked eye are removed.

.3 The Contractor shall initiate quality control measures during the fabrication and installation of all ductwork to clean/keep clean all ductwork, so that ductwork cleaning may not be required at the completion of the work. Consultant shall review cleanliness of ductwork, and at the sole discretion and direction of the Consultant, the ductwork cleaning requirements of this section may be required, reduced or eliminated. However, if the ductwork does require cleaning, it shall be done as per the requirements of this section, and shall be at no additional cost to the Owner.

1.2 Definitions

.1 Clean: No visible particulates or deposition in air systems after vacuum techniques have been completed.

.2 Air Systems: Includes central equipment; supply, return, exhaust fans, coils, dampers, turning vanes, grilles, diffusers, high, medium and low pressure ductwork (supply, return and exhaust) that is associated with an air handling system.

1.3 Quality Assurance

.1 Ductwork cleaning firms shall be specialists in this field.

.2 The HVAC system cleaning sub-trade shall be a certified member of the National Air Duct Cleaners Association (NADCA) or equivalent.

.3 The Owner may hire an independent agency to review duct cleaning procedures prior to starting work and perform spot checks to confirm that duct system cleaning has been effectively executed.

1.4 Related Work Specified in Other Sections

.1	Cleaning	Section 01 74 11
.2	Common Work Results for HVAC	Section 23 05 00
.3	Metal Ducts	Section 23 31 13
.4	Air Duct Accessories	Section 23 33 13

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Approved agencies

.1 Contractor to submit proposed agency for Consultant and Owner approval.

1.7 Submittals

.1 Submit certification of NADCA membership (or equivalent).

.2 Submit list of five (5) recent projects of similar magnitude.

.3 Submit the name of the superintendent-in-charge of the work and list his project experience.

.4 Submit an outline of the work scope for each ductwork system for review prior to starting work, including lighting strategy and procedures, cleaning procedures, equipment, materials, and schedule.

.5 Submit a certificate of completion for each ductwork system that cleaning has been completed as defined in the specifications.

2. Products

Not Applicable

3. Execution

3.1 Preparation

.1 All ductwork shall be wiped clean prior to installation.

.2 Oil film on sheet metal shall be removed before shipment to Work Site. Finished ductwork shall be stood vertically for 72 hours to allow oil remnants to drains as indicated by SMACNA. Ducts shall be inspected for oil remnants prior to shipping to site.

.3 Close all dampers immediately following installation thus checking the operation and retarding movement of contaminants through the system.

.4 Seal all openings at the end of each day and at such other time as site conditions dictate.

.5 Floor openings to be capped with sheet metal or floor grilles plus 0.15 mm (6 mils) thick poly sheet.

.6 Other openings to be covered with 0.15 mm (6 mils) thick poly sheet taped so as to be air tight.

3.2 Installing Access Doors

.1 Provide and locate access doors and install as follows:

.1 At 12.0m (36 ft) intervals in vertical ducts.

.2 Horizontal ducts at intervals of 6m (18 ft).

.3 At the base of all duct risers.

.4 Both sides of turning vanes in all ducts.

.5 At each fire damper location.

.6 At each side of all coils except where an access is provided.

.7 At all locations of internally duct mounted equipment or devices including balancing dampers, automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and controls, except where access is provided.

.8 Where required to facilitate duct cleaning.

3.3 Cleaning

.1 On completion of the duct and plenum installation and prior to the installation of air terminals and prior to balancing of the air systems, but not until the areas are substantially clean (floors have been swept and vacuumed) and all "dirty" construction has been completed, employ an approved Cleaning Agency to vacuum clean the following:

.1 All air handling units.

.2 All plenums.

.3 All supply and return air ducts.

.4 All exhaust air ducts.

.2 All components within each system shall be thoroughly cleaned and shall include but not be limited to the following: coils, fans and motors, silencers, air terminals and mixing boxes / air terminal boxes.

.3 When connecting to existing supply ductwork, clean existing supply ducts upstream from connection back to the filters. Clean existing supply ductwork downstream from new connections to outlets.

.4 Cleaning shall generally be by high capacity power vacuum. High-pressure compressed air, wire brushing and/or non-toxic solvent cleaning shall be used where dirt or scale cannot be removed otherwise. Coils shall be de-scaled.

.5 Coils shall be de-scaled.

.6 Install temporary filters as follows:

.1 Behind all grilles and diffusers.

.2 In front of all duct coils.

.3 At inlet of all terminal high velocity units to protect pitot openings.

.7 The Cleaning Contractor shall be responsible for removing and replacing filter media. This contractor will remove the temporary filters and replace with new after cleaning the systems.

.8 The Cleaning Contractor shall mark balancing damper positions before cleaning and return them to their original position when cleaning is completed unless the system is still to be balanced.

.9 Reinstall any grilles, registers and diffusers, which may have been removed for cleaning purposes.

.10 After the duct systems have been cleaned they shall be resealed if they are not being used. Provide filter media on the return air terminals, in a ducted return system, if the return air fans are run after cleaning has been completed. Where the ceiling is being used as a return air plenum, provide filter media on the return air opening at the shaft.

.11 The Cleaning Agency shall perform a full inspection of the duct interior. Utilizing a fibre optic borescope with dedicated light source, inspect interior ductwork surfaces, and ductwork accessories including terminal units, mixing boxes / air valves, ductwork liners, duct-mounted coils, filters, dampers, humidifiers and all other appurtenances within the ductwork system.

.12 Spot checks will be made by the Consultant during the cleaning process to verify that the required standard is being met. When substantial performance is claimed, final spot checks will be made to verify that the ducts are clean. Make available for the use of the Consultant a fibre optic borescope with dedicated light source. If any ducts are found to be unclean, then they shall be recleaned.

.13 Ducts serving very clean areas served with 85% NBS or HEPA filters shall be reviewed by the Consultant utilizing the equivalent of a white glove wipe technique.

.14 Submit a report from the cleaning agency that certifies all specified air systems have been cleaned

3.4 Inspection

.1 Ductwork cleanliness will be inspected using a periscope built of 75mm (3”) diameter tube, mirrors and flashlight.

.2 Ductwork found to be dirty shall be re-cleaned at contractor’s expense.

.3 Ductwork cleanliness shall be inspected by the mechanical engineer.

END OF SECTION

1. General

1.1 Intent

.1 Work in Division 21, 22 and 23 will include all drawings and all sections of the specifications that form the Contract Documents, including all addenda, and including Division 00 and Division 01, whether defined in Division 21, 22 and 23 or elsewhere, or whether defined in mechanical drawings or elsewhere.

.2 Provide complete, fully tested and operational mechanical systems to meet requirements described herein and in complete accord with applicable codes and ordinances. Include all costs to obtain all permits and to pay for all fees and charges, including inspection charges by the authorities that issue the permits. Coordinate all related inspections. Permits, fees and inspections including:

- .1 Ventilation
- .2 Water treatment
- .3 Building HVAC
- .4 Building plumbing
- .5 Natural gas
- .6 Sprinklers
- .7 Fire Protection
- .8 Third party engineering fees

.3 Contract documents consisting of the specifications and drawings, are generally diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are <u>not</u> detailed installation instructions.

.4 Review Contract Documents and notify the Consultant of issues or conflict that require clarification prior to submitting tender. Failure by the Contractor to secure clarification does not relieve the Contractor to comply with the intent of the design and/or the Contract Document.

1.2 Related Requirements

.1 Refer to and comply with the following sections:

.1	General Requirements	Division 01
.2	Submittal Procedures	Section 01 33 00
.3	Delegated Design Submittals	Section 01 33 50
.4	Quality Control	Section 01 45 00

.5 Temporary Facilities and Controls — Section 01 51 00

.6 Execution Requirements — Section 01 73 00

.7 Closeout Procedures — Section 01 77 00

.8 Closeout Submittals — Section 01 78 00

.9 Demonstration and Training — Section 01 79 00

.10 General Commissioning (Cx) Requirements — Section 01 91 13

.11 Building Management Manual (BMM) — Section 01 91 51

1.3 Related Work Specified in Other Sections

.1 Bidding Requirements and General Conditions of Contract — Division 01

.2 Electric Motor Power Characteristics — Division 26

.3 Fire Alarm System — Section 28 31 03

.4 Excavation and Fill — Section 31 23 00

1.4 Codes, Regulations, Permits, Fees and Inspections

.1 Conform to the latest edition and supplements of the following for all materials and installations:

.1 National Building Code of Canada

.2 Alberta Building Code, as amended by local bylaws and Provincial Statutes.

.3 National Energy Code.

.4 National Fire Protection Association.

.5 Codes, Standards, Bylaws, Statutes and Manufacturer’s Association Specifications or instructions mentioned in Division 21, 22 and 23 sections, refer to latest revisions thereof at time of calling of bids, unless specifically designated otherwise.

.6 In no instance shall the standard established by the drawings and specifications be reduced by code or otherwise.

.7 Where conflict or discrepancies between Codes, Standards, Bylaws, Statutes, Specifications, Drawings, etc., exist, the most stringent requirement shall apply.

.8 Furnish all notices, obtain all necessary permits related to Division 21, 22 and 23 work.

1.5 Installation Requirements

.1 Provide labor, material and tools required to install, test and place into operation, a complete mechanical system. Provide additional material for modifications required to correct minor job confliction.

.2 Install material and 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 as determined by the Engineer. Field verify all dimensions, clearances, maintenance clearances, equipment handing requirements, invert elevations, and other similar measurements prior to any fabrication and installation. Notify the Consultant of any discrepancies that require resolution.

.3 Confirm invert elevations and locations of connection to utilities before any excavation work is started.

.4 Install piping and ductwork only in concealed spaces, unless otherwise approved.

.5 Remove and replace improperly installed mechanical work, or work that requires modifications due to coordination issues or conflicts.

.6 Review architectural drawings and confirm that plumbing fixtures defined on Architectural Drawings are consistent with plumbing fixtures defined on mechanical drawings. Mechanical work shall include supply and installation for all fixtures defined in the contract documents.

.7 Refer to Architectural Drawings and Structural Drawings for sections, details, dimensions and information such as fire separations, expansion joints, roof construction, wall construction that has impact on the mechanical installation.

.8 Examine contract documents prepared by all disciplines and confirm that work can be installed as defined. No allowance will be made for changes unless the consultant has been notified in writing prior to tender close.

.9 Follow manufacturer’s recommended installation details and procedures for equipment, supplemented by details given herein and on plans subject to approval of the consultant.

.10 Locate distribution systems, access doors, equipment and materials for maximum usable space to satisfaction of consultant.

.11 Install equipment in a manner to facilitate maintenance and ease of repair or replacement. Provide for adequate access and sufficient clearances.

.12 Equipment used shall not exceed space limitations in any dimension. Replace any equipment or apparatus which does not meet this Specification at no cost. Assume full responsibility for the expense of redesign and adjustment to other parts of the building when proposing the use of acceptable equal or alternate equipment. It is the contractor’s responsibility to confirm all quantities. Dimensions, performance and accessories required for all equipment, including matching “standard” and operational accessories between “equal” and “acceptable” products/suppliers/manufacturers.

.13 Prepare dimensioned drawings showing sleeving, recesses, furring and openings to coordinate mechanical work with other trades.

.14 Prepare dimensioned drawings for congested areas such as mechanical rooms, shafts, corridors and spaces that require special attention to complete the installation.

1.6 Provisions for Maintenance

.1 Install piping in racks with clearance in between pipes equal to the pipe diameter. Where piping is stacked, provide a minimum 300mm (12”) clearance in between stacks.

.2 Install maintainable components such as valves, motors, traps, air vents, dampers, filters, and coils in a manner to facilitate proper access for maintenance.

.3 Install major equipment components such as pumps, fans, dry coolers, chillers at floor level unless indicated otherwise. Install piping connections with isolating valves located to allow component removal with minimal system drainage.

.4 Locate flanges/unions to allow equipment removal without interruption to piping work.

.5 Allow adequate space for removal of equipment and components from the mechanical room space.

.6 Install “Pete’s Plugs” gauges and metering equipment in readily accessible and visual locations.

.7 Provide extensions to grease cups, lubrication fittings for bearings, etc. to outside of fan cabinets.

.8 Provide maintenance platforms, ladders, safety rails to Occupational Health and Safety Standards to accommodate equipment and components not easily accessed from the floor.

.9 Provide lifting lugs attached to the building structure above motors and equipment that weight in excess of 50 kg (110 lb).

.10 Allow minimum clearance in front of electrical components, such as motor control centers, starters, VFDs, control panels in accordance with applicable codes.

1.7 Warranty

.1 Comply with warranty requirements defined in Division 01.

.2 Furnish a written guarantee stating that all work executed in this contract will be free from defective workmanship and materials for a period of one (1) year from the date of substantial performance of work. The Contractor shall repair and replace any work which fails or becomes defective during the term of the guarantee/warranty, providing the operating and maintenance instructions have been complied with. The period of guarantee specified shall not, in any way, supplant any other guarantees of a longer period provided by Manufacturers or as called for in the project documents.

1.8 Owner Requirements During Warranty

.1 Unless specified otherwise the Owner shall be responsible for all routine maintenance requirements as required in the manufacturer’s instructions.

.2 The Owner shall be responsible for supplying replaceable components such as filters and belts during the warranty period.

1.9 Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or manufacturer and model for each specific application.

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

.3 Provide statically and dynamically balanced rotating equipment for minimum vibration and low operating noise levels. Provide balancing certificates if requested by the consultant.

.4 Replace materials or workmanship below specified quality and relocate work wrongly placed to satisfaction of the Engineer and at no cost to the Owner.

.5 Install materials and equipment in a quality manner providing good workmanship by competent tradesmen. At the request of the consultant, provide certificates proving competency of specialists employed. Certificates shall be from recognized, related governing associations. The owner and his representatives reserve the right to terminate any specific person’s employment on this project for failure to prove adequate qualifications and/or workmanship.

.6 If shop drawings are rejected technically after 3 submissions, the Contractor at no additional expense to the Owner shall revert the specified product and manufacturer for this project.

1.10 Availability of Equipment and Materials

.1 Make known in writing to the Engineer ten (10) days prior to the tender closing date any materials specified that are required to complete the work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the tender price.

.2 If requested after contract award, provide within 24 hours a list of equipment and manufacturers to be used on this project. This list shall not be deviated from unless delivery, performance, or dimension issues require a change to be reviewed by the Consultant.

1.11 Alternate Materials and Equipment

.1 Comply with the requirements of Division 01.

.2 The price submitted for this contract shall be based on the use of materials and equipment as specified or as contained within the acceptable equivalent manufacturers listed in each section.

.3 Requests for approval for tendering purposes of equivalent materials or equipment shall be submitted in duplicate, to the Engineer no later than ten (10) working days prior to the closing date of tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by addendum and consistent with all requirements defined in Division 01.

.4 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Engineer. In the event that the product has been approved as an "Alternate Only", this shall be stated in the quotation and the difference from the base bid price indicated.

.5 Approved equivalents and/or alternatives to specified products shall be equal in performance and materials to the specified product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined. . Equipment which is not equal will be replaced with the specified equipment at no cost to the Owner.

.6 The Contractor shall be fully responsible for all costs for work or materials required by the trades or other contractors to accommodate use of other than specified materials or equipment.

.7 Manufacturers/suppliers which are noted in individual sections as “Acceptable Manufacturers” are automatically approved for bidding and are not required to follow the approval process. All other manufacturers/suppliers must follow the approval process. “Approved Manufacturers” must meet all requirements of specified equipment.

1.12 Metric Conversion

.1 All units in this division are expressed in SI units. Soft metric conversions are used throughout.

.2 Submit all shop drawings and maintenance manuals in SI units.

.3 On all submittals use the same SI units as stated in the specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial

.1 Where pipes are specified with metric dimensions and only Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are available and are provided, the contractor shall provide adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

.3 Record accurately on "as-built" drawings the type of pipe (i.e., Metric or Imperial) installed.

Equivalent Nominal Diameters of Pipes

mm	inches	mm	inches	mm	inches
3	1/8	65	2-1/2	375	15
6	1/4	75	3	450	18
10	3/8	100	4	500	20
15	1/2	125	5	600	24
20	3/4	150	6	750	30
25	1	200	8		
30	1-1/4	250	10		
40	1-1/2	300	12		
50	2				

.5 Metric Duct Sizes

.1 The metric duct sizes are expressed as 25mm = 1inch.

1.13 Drawings And Specifications

.1 Refer to architectural drawings for building dimensional data and construction details.

.2 Drawings and specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both. Any item omitted from one but which is mentioned or reasonably implied in the other shall be considered as properly and sufficiently specified.

.3 Should any discrepancy appear between drawings and specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and specifications, obtain a ruling from the Engineer in writing or by Addendum, before submitting tender. If this is not done, it will be assumed that the most expensive alternate has been included.

.4 Where errors or discrepancies appear in catalogue numbers, provide the material in accordance with the system requirements and to the standard of the specifications.

.5 Prior to construction start, examine all contract documents, including all drawings and specifications, and work of other trades to ensure that work can be satisfactorily carried out without changes to building.

.6 The scope of work in this division shall include all work defined in the Contract Documents, including work which may exceed the minimum requirements of codes and standards that are referenced in the Contract Documents.

1.14 Examination Of Site

.1 Before submitting tender, visit and examine the site and note all characteristics and features affecting the work. Report discrepancies to the Engineer seven (7) days prior to tender closing. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the site or item existing, thereon, which are visible or known to exist at the time of tender. Failure to advise Engineer of discrepancies will assume contractor accepts documents as presented without potential of additional costs.

1.15 Equipment Delivery, Storage and Cleanup

.1 Arrange, and coordinate, storage space with the General Contractor. Materials and equipment shall be stored in a safe, dry location and shall be protected against weather, damage and theft.

.2 Materials to be delivered to site in original factory packaging with manufacturer’s labeling including name and address.

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

.4 Protect equipment with polyethylene covers and crates.

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

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

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

.8 Ensure that existing equipment to be turned over to the Owner or reused is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

.9 Existing equipment that is to remain in place, and be reused, is to be protected from physical damage including freezing.

1.16 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Section 01 74 11 – Cleaning.

.2 Do not dispose of unused paint material into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.

1.17 Coordination Of Work

.1 Cooperate and coordinate with other trades on the project. Phase work in sequence with the General Contractor.

.2 Make reference to electrical, mechanical, structural and architectural drawings when setting out work. Consult with respective Divisions in setting out locations for ductwork, equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Provide coordination drawings showing the work of all trades and contractors involved, in areas of potential conflict or congestion, as requested by Engineer at no additional cost.

.3 Where dimensional details are required, work with the applicable architectural and structural drawings.

.4 Full size and detailed drawings shall take precedence over scale measurements from drawings.

.5 Prepare and submit drawings showing sleeving, recesses, and formed work in concrete.

.6 Prepare and submit drawings for all shafts, duct openings, roof openings and similar requirements.

.7 Coordinate with the Construction Manager and Electrical Trade all requirements for electrical services to mechanical components and equipment. Motor voltages will be defined in Division 26.

.8 Using shop drawing data, prepare a comprehensive list to define all specific electrical requirements needed by the Division 21, 22 and 23 work to complete the installation. Coordinate with Electrical Trade.

.9 Prepare and submit drawings to the Construction Manager and structural Consultant defining mechanical system support loads and support details. Include definition of pipe and/or loads on structural elements and anchor arrangements.

1.18 Coordination with Division 26 (Electrical) Work

.1 Provide motors or mechanical equipment with voltage and phase characteristics as defined in Division 26.

.2 Comply with the requirements in Section 20 05 13 – Electric Motors.

.3 Prior to ordering any motor driven mechanical equipment, meet with the electrical trade and confirm all electrical interface requirements with mechanical components.

.4 Division 20, 21, 22 and 23 (Mechanical) Trade shall:

.1 Submit a list of all motor specifications and electrical connections to mechanical equipment, outlets, components, panels and point source requirements. Maintain list up-to-date and make available for site review.

.2 Include final motor list in O&M Manuals.

.3 Supply and install all low voltage (24 V) control devices, temperature control systems including direct digital central systems defined in Section 23 09 (Series), Controls.

.4 Supply and set in place all variable frequency drives, including start-up and commission.

.5 Supply and install 110 V wiring interface with control devices on packaged equipment, such as liquid level controllers and multi-speed controllers.

.6 Supply and install all low and live voltage wiring associated with automatic control systems defined in Sections 23 09 (Series), Controls.

.7 Provide CSA labeling on all mechanical equipment with electrical components.

.8 Provide all on-site interconnecting wiring for connecting loose electrical components supplied with mechanical equipment.

.5 Division 26 (Electrical) Trade will:

.1 Supply and install all electrical components which are required, but not part of Division 20, 21, 22 and 23 supplied packaged equipment.

.2 Provide wiring interface from distribution equipment to variable frequency drives (VFDs) and from VFDs to motors.

.3 Extend power wiring from electrical centers to packaged equipment that contains electrical components.

.6 Refer to Division 26.

1.19 <u>Cutting and Patching</u>

.1 Provide inserts, holes and sleeves, cutting and fitting required for mechanical work. Relocate improperly located holes and sleeves.

.2 Provide inserts or drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from Engineer before drilling, coring, cutting or burning structural members. Ensure post tensioned or pre-stressed strands are located accurately and avoid with an adequate margin of safety.

.4 Cutting practices shall be limited to neat openings created through recognized drilling or coring practices.

.5 Use only National Building Code approved and rated process and materials for filling of voids. All processes and materials are subject to the approval of the Fire Commissioner. Maintain integrity of fire separation.

.6 Provide openings and holes required in precast concrete members for mechanical work. Cast holes larger than 100mm (4”) in diameter. Field-cut holes smaller than 100mm (4”) if location is approved.

.7 Patch and make good building where damaged from equipment installation, improperly located holes etc. Work to be performed by the trade or contractor responsible for that type of work.

1.20 Excavation and Backfill

.1 Refer to and comply with requirements of Section 31 23 33.01 – Excavating, Trenching and Backfilling.

.2 Prior to start of excavation confirm all service invert elevations and locations. Set grades to suit.

.3 Provide all labor and materials for trench excavation inside the building that is required to accommodate installation of the mechanical work, including shoring and pumping. No cutting, boring or excavating necessary for this work in or about the building which may cause interference with the progress of the work or weaken the structure in any way, shall be undertaken without the approval of the Consultant before commencing work. Trenches or tunnels for all underground piping shall be excavated to a depth slightly more than required and graded so as to secure all available fall. Support each length of pipe with concrete blocks and bricks, or backfill the trench with gravel to the required depth and grade. Storm lines outside of the building shall be kept as deep as practical.

.4 Backfilling in trenches shall be with sand or pea gravel where approved, 150mm below pipe and up to 150mm over top of piping, then flushed with water so as to ensure the total length of each pipe is resting on solid footing. Remainder of all trenches shall be filled by the General Contractor.

.5 Where sewer lines pass under a grade beam or footing the trench around the piping up to and in contact with the footing, provide a 450 kg concrete grouting so as to seal the outside trenching from normal storm runoff and backflow of rain water through the trenching and into the crawl space and/or under the basement floor.

.6 Where sewer pipes pass through exterior walls below grade, the General Contractor shall install corbels on the exterior walls and run bridging from corbel to undisturbed soil for the support of the pipes. One inch thick waterproof mastic shall be applied around the pipes which pass through the wall.

.7 Repair concrete walls, pavement, walks, louvers, etc., where these have been damaged by the mechanical contractor.

.8 Do not install buried pipe until foundation work (i.e. piles, footings, etc.) within 15m (50 ft) of piping has been completed.

1.21 Site Utility Services

.1 Arrange and coordinate all connections to street mains and metering requirements with the respective utility company.

.2 Coordinate interruption of services to existing facilities with the Contractor.

.3 Provide accurate, dimensioned record drawings of natural gas utilities on the property. Dimensions are to be referenced to the building footprint. Provide invert elevations.

.4 Remove from site and dispose of packaging materials at appropriate recycling facilities.

1.22 Temporary Heat

.1 Refer to Section 01 51 00 – Temporary Utilities.

.2 The building systems shall not be utilized for temporary heat. The contractor may provide a proposed temporary heat agreement to the Owner for review. However, the agreement may or may not be accepted, and as a minimum, the following requirements would have to be met:

   .1 The agreement shall include payment schedule for utilities, spare parts listing and confirmation of warranty.

   .2 Thoroughly clean and overhaul permanent equipment used during the construction period, and replace worn or damaged parts before final inspection at the sole discretion of the Consultant.

   .3 Use of permanent systems for temporary heat shall not modify terms of warranty. Equipment Manufacturers shall certify that equipment is in "new" condition at start of warranty period.

   .4 Operate heating systems under conditions which ensure no temporary or permanent damage. No water systems shall operate without proper water treatment or blow-down. Operate fans at proper resistance with filters installed. Change filters at regular intervals. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

   .5 Air systems may not be used for temporary heating.

   .6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company monitoring system.

   .7 Avoid thermal shock to heating system during planning, construction and operation of temporary heating system.

1.23 Temporary or Trial Usage

.1 Temporary or trial usage requested by the Owner of mechanical equipment supplied under contract shall not represent acceptance. Operate and maintain all equipment and systems during trial usage.

.2 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.3 For all ventilation systems, the operation of the system shall be pre-tested by running the units in their designed maximum fresh air, maximum exhaust air mode once all distribution ductwork is installed. Inspect filters bi-monthly; change filters if pressure drop exceeds manufacturer's recommended operating limit.

.4 The ventilation system trial use date shall be approved by the Engineer.

1.24 Welding

.1 Use fully qualified welders licensed by the provincial authorities.

.2 For field welding, comply with the procedures of CSA W117.2-M87 "Code for Welding and Cutting (Requirements for Welding Operators)".

.3 Welding materials, fabrication standards and labour qualifications must conform to ANSI/ASME B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations.

.4 Use pressure welders for work on systems containing pressure in excess of 103.4 kPa (15 psig).

.5 Weld in accordance with the requirements of the Provincial Boiler Inspection Branch.

.6 Submit a statement describing welding procedures proposed for the review of the consultant before commencing work.

.7 Before proceeding with the welded joining on the entire piping system, prepare not more than ten sample joints for the on-site review by the consultant. The consultant may request the cutting out of one or more welding joints for close visual examination or x-ray test. Once the consultant has reviewed the samples, the remaining pipe welding joints shall be to the standard accepted.

.8 Welded joints shall be free of defects including: elongated slab, isolated slag, porosity, incomplete penetration, lack of fusion, burn-through, cracks, arc burn, internal concavity, hollow beads, internal undercuts, and external undercuts.

1.25 Weld Tests

.1 Unless otherwise stated, the quality and interpretation of the radiography performed under this specification shall conform to CSA Standard Z183, Oil Piping and Z184, Gas Piping ANSI ASME B31.1 Pressure Piping, B31.3 Refinery Piping and UW51, UW52 Pressure Vessel Codes and all related standards.

.2 All welded joints on piping, regardless of service, but including as a minimum, natural gas, heating, chilled water and condenser water, low and high pressure steam and condensate shall be subjected to radiographic inspection with costs borne under the mechanical construction contract.

.3 Equivalency of weld quality testing may be granted to the contractor on the following basis at the consultants discretion:

.1 The contractor submits, to the consultant, and obtains approval of a corporate quality control procedures manual for welding practices.

.2 5% of welds as a minimum, shall be radiographed on all welded services.

.3 A minimum of two (2) welds shall be radiographed on all services where there are fewer than twenty (20) welds on the service.

.4 If defects are recorded which, in the opinion of the consultant, are serious, the consultant may request further radiograph testing of welds to a maximum of 100% of all welded joints at his discretion. The contractor shall bear all related costs of these extra testing procedures as an acknowledgement of maintenance of project quality requirements.

.4 A senior radiographer with Canadian Government Standard Board Level 2 qualifications shall be in the field supervising the radiographic operations under contract.

.5 Prior to beginning work, the following requirements shall be fulfilled:

.1 The radiographic contractor shall supply the consultant with written evidence of each radiographer’s certification in accordance with “Welds and Weldments” CGSB 48-G04, latest edition.

.2 The radiographer shall be required to satisfactorily make two (2) qualification radiographs, which will include exposing and processing the radiographs and interpreting the radiographs in accordance with applicable code. One (1) copy of the qualification radiograph shall be kept by the consultant and shall be used as a standard against which the quality of production radiographs can be checked.

.6 The radiographer shall be responsible for the protection and personal monitoring of every man working with or near radiation in accordance with the regulations of the Department of Health and Welfare, Radiation Protection Division. When crank-out type Isotope camera is used, the area affected by radiation shall be surveyed and limits of hazard posted.

.7 Submit all certified test reports to the consultant.

1.26 Testing of Soldered Copper Joints

.1 The Engineer, at any time, may select up to five (5) sample soldered copper joints from installed pipe for review. Samples provided shall be split longitudinally for visual review.

.2 If the submitted samples do not pass a visual inspection to the satisfaction of the Engineer, the contractor shall arrange and pay for radiographic testing of the samples to verify quality of workmanship.

.3 Rejection of a sample will require re-test of adjacent joints at the contractor's expense.

.4 Failure of more than 75% of the above removed samples will necessitate removal and replacement of all joints completed up to the time of test, at contractor’s expense.

1.27 Stray Currents

.1 All wet lines shall be tested for stray currents at total contract performance.

.2 Isolate and correct stray currents to minimize electrolytic action potential.

1.28 Shop Drawings

.1 Submit shop drawings and product data in accordance with Division 1 to consultant for approval prior to ordering material. Shop drawings are to be submitted electronically (PDF) and electronic copies will be provided in return with consultant comments and review stamp. Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Space must be left on the shop drawing to accommodate the Engineers review stamp. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.

.2 Prior to submission to the Engineer, the Contractor shall review all shop drawings. By this review, the Contractor certifies that he has determined and verified the following:

.1 Measurements are verified with field installation space requirements.

.2 “Handing” of equipment for access and maintenance is correct.

.3 Access for maintenance requirements is defined.

.4 Field connections for wiring, controls, piping and ductwork connections are defined.

.5 Electrical service connections and characteristics are defined.

.6 Work required by other trades is defined.

.7 Vendor’s catalogue numbers are correct and consistent with the system performance criteria.

.8 Shop drawings meet all requirements of the contract documents.

.3 The Contractor's review of each shop drawing shall be indicated by stamp, date and signature of a responsible person.

.4 Identify materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Engineers office. Maintenance and operating manuals are not suitable submittal material. Where equipment is identified by name or number on the drawings or specification, clearly mark each shop drawing with the identical name and/or number.

.5 Clearly mark each sheet of submittal material (using arrows, underlining, or circling) to show differences from what is specified, particularly sizes, types, model numbers, rating, 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.

.6 Include dimensional and technical data sufficient to check if equipment meets requirements. Include wiring, piping, service connection data and motor sizes.

.7 Submittals shall be made in BOTH metric and English units.

.8 Installed materials and equipment shall meet specified requirements regardless of whether or not shop drawings are reviewed by the Engineer.

.9 The shop drawing review by the Engineer will provide the following certification: "Review by Stantec is for the sole purpose of ascertaining general conformance with design. Contractor is responsible for dimensions, fabrication and construction methods, coordination of sub-trades, detail design of components, and errors or omissions on shop drawings."

1.29 Record Drawings

.1 Comply with Division 01:

.1	Closeout Procedures	Section 01 77 00
.2	Closeout Submittals	Section 01 78 00
.3	Building Management Manual (BMM)	Section 01 91 51

.2 The contractor shall keep, on site, available to the Engineer at all times and particularly for each regularly scheduled site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of drawings is to be used only for this purpose, and must not be used as the daily general reference set. Make record drawings available for reference and inspection at all times.

.3 Provide record drawings which identify location of smoke and fire dampers, major control lines, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include, in general, items that are significant or are hidden from view and items of major importance to future operations and maintenance, and to future alterations and additions including cleanouts and isolation valves.

.4 Include on drawings, all addenda and construction contract changes.

.5 Identify each drawing in lower right-hand corner in letters at least 12mm high as follows: "RECORD DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED", signature of contractor and date.

.6 The cost of producing and plotting the AutoCAD record drawings shall be included in the tender price. Periodic checks will be carried out to verify that the record drawings are being kept up to date.

.7 At substantial completion, transfer all deviations, including those called up by addenda, revisions, clarifications, shop drawings, and change orders, to AutoCAD 2010 files. Drafting quality layers, symbols, etc. shall be identical to original drawings. Prior to substantial performance, turn over a CD containing AutoCAD 2010 drawing files and one (1) complete set of hardcopy record drawings.

.8 Each “record” drawing shall bear the Contractor’s identification, the date of record and the notation “We hereby certify that these drawings represent the “Work Record of Construction”. The Contractor’s signature and company seal shall be placed below that notation.

.9 Enter dimensions from building line to all buried services, including coordinates of manholes, catch basins, tanks, outside shut-off valves, and other similar elements.

.10 Service connections to water and sewer lines entering a building shall be recorded as to horizontal dimension from a convenient building element with suitable depth elevations relating to main floor level and sea level datum.

.11 Sewer and water lines which are placed beneath floor slabs shall be located such that each point of entry, change in direction, and irregularity is located by dimension from column grid lines on the record drawings. Depth below slabs shall be given.

1.30 <u>HVAC Systems Testing and Startup</u>

.1 Conduct system startup and testing of systems.

.2 Quality Assurances

.1 Test equipment and material where required by specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with applicable portions of ASME, ASHRAE, SMACNA and other recognized test codes.

.3 Perform tests on site to the satisfaction of the Engineer. Tests are to be witnessed by the Consultant and the authorities having jurisdiction. Attendance at tests shall be at the discretion of the Consultant.

.4 Piping or equipment shall not be concealed or covered until installation is inspected and approved by the Engineer. Provide written notice to the Engineer at least three (3) days in advance of tests or concealing of piping.

.5 Coordinate with engineer at start of the project, those tests that will require witnessing by the Engineer.

.6 Submit sample test certificate forms for review two (2) weeks prior to any testing on site.

.7 Should a test fail, make repairs and retest until the results are satisfactory to the Consultant and authority having jurisdiction.

.3 Liability

.1 Take charge of plant during tests, assume responsibility for damages in the event of injury to personnel, building or equipment and bear costs for liability, repairs and restoration in this connection.

.4 Submittals

.1 Obtain certificates of approval and acceptance, complying with rules and regulations from authorities having jurisdiction. Submit copies to be included in Operating and Maintenance Manuals.

.2 Perform tests as specified. Include test certificates in Operating and Maintenance Manuals. Itemize each test as to the time performed and personnel responsible. Submit written report to the consultant within 48 hours after the tests have occurred.

.5 Execution

.1 Provide equipment, materials and labor for tests and pay expenses. Use test instruments from approved laboratory or manufacturer and furnish certificate showing degree of accuracy and date of calibration. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for 8 hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 During heating and cooling system tests, check linear expansion at elbows, U-bends, expansion joints and offsets, for proper clearance. Restrain manufactured expansion joints during hydrostatic tests in accordance with manufacturer’s recommendations.

.4 Should tests indicate defective work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by remaking joints in screwed fittings, cutting out and rewelding welded joints, remaking joints in copper lines. Do not caulk.

.5 Conduct all tests as work is completed and conditions permit, or on portions of systems as directed by consultant.

.6 Gas fired appliances to be subjected to Gas Inspection Branch operational tests.

.7 Visually check joints during tests for leakage of water test media or in systems with air or nitrogen tests check joints with soap bubble test.

1.31 HVAC Equipment Testing and Startup

.1 Conduct performance testing of equipment and arrange for manufacturer’s startup of equipment.

.2 Quality Assurance

.1 Use factory trained representatives and submit manufacturer's check sheets for starting all systems and equipment.

.2 Testing and certification of each backflow prevention device shall be by an "Approved Cross Connection Installation Specialist". One copy of the certificate to be submitted to the Water Purveyor, and one copy is to be inserted in each O & M manual.

.3 Prior to starting, testing, balancing, adjusting, and cleaning processes, verify with Engineer any tests required to be witnessed. Provide sufficient notice to Engineer prior to commencement of procedures.

.4 Engineer shall be allowed to witness any testing, adjusting, starting, balancing, and cleaning procedures.

.5 Assume all costs associated with starting and testing, including the supply of testing or cleaning medium.

.6 Prior to starting equipment or systems, secure and review manufacturer's installation, operation, and starting instructions. Read in conjunction with procedures defined herein.

.7 Use manufacturer's or supplier's starting personnel where required to ensure integrity of manufacturer's warranty.

.8 Compare installations to published manufacturer's data and record discrepancies. Items potentially detrimental to equipment performance shall be corrected prior to equipment starting.

.9 Some processes involved in starting procedures defined in this section may be duplications of authorities verification. To facilitate expedient completion of project, arrange for authorities to assist or witness these procedures.

.10 All starting, testing, and procedures shall be in accordance with applicable portions of ASME, ASHRAE, AABC, CSA, NFPA, SMACNA, ASTM, ASPE and as required and outlined in these specifications.

.11 Personnel involved in starting, testing, balancing and adjusting procedures shall be experienced in the design and operation of mechanical equipment and systems being checked and shall be able to interpret results of the readings and tests.

.12 Assume all liabilities associated with starting, testing and balancing procedures.

1.32 Demonstration and Owner’s Instruction for HVAC Systems

.1 Arrange for demonstration of HVAC equipment and systems operations.

.2 Arrange for instruction seminars for Owner’s personnel.

.3 Comply with the requirements of Section 01 79 00 – Demonstration and Training.

.4 Quality Assurance

.1 The mechanical contractor shall arrange for sub-trades and manufacturer's representatives to be available for demonstrations and seminars.

1.33 Operation and Maintenance Manuals

.1 Secure and assemble all necessary literature describing the operation and maintenance of all equipment provided. Complete and transmit documentation for review to Engineer at project milestones.

.2 Quality Assurance

.1 Work specified shall be performed by an Independent Agency specializing in this type of work.

.3 Approved Agencies

.1 The contractor is to submit a proposed agency for Consultant and Owner approval.

1.34 Certificate of Substantial Performance

.1 Comply with Division 01:

.1	Closeout Requirements	Section 01 77 00
.2	Closeout Submittals	Section 01 78 00
.3	Demonstration and Training	Section 01 79 00
.4	General Commissioning (Cx) Requirements	Section 01 91 13
.5	Building Management Manual (BMM)	Section 01 91 51

.2 Submit Alberta Building Code "C-2" form signed by a Professional Consultant registered in Alberta confirming that automatic sprinkler installation and standpipe systems are installed and tested, consistent with the contract documents.

.3 In addition to the requirements of Division 01, and prior to application for a "Certificate of Substantial Performance" of the work, the contractor shall certify the following in writing to the Consultant:

.1 The systems are installed and suitable for operation for the purpose intended.

.2 Fire protection, plumbing, heating, and ventilation systems are capable of operation with safety devices and alarm controls functional and automatic controls in operation and the Owners personnel have had their initial training programs.

.3 All equipment within mechanical rooms is installed.

.4 All thermal and acoustic insulation is installed.

.5 All static pressure tests are complete.

.6 All access doors are suitably located, and equipment easily accessible.

.7 All piping is installed, painted and clearly identified complete with flow arrows.

.8 Systems are chemically cleaned, flushed, and water treatment initiated.

.9 Temporary filters are installed and fan plenums cleaned.

.10 All equipment is checked for operation, alignment amperage draw and rotation.

.11 Rough balance of air and water systems is completed and the reports have been submitted for review.

.12 All equipment is lubricated as per manufacturer's data.

.13 All valves are tagged and all equipment identified. Painting of equipment is completed and escutcheons are installed.

.14 All unit heaters and cabinet unit heaters are installed and electrical connection made.

.15 All fans, pumps and equipment are installed and electrical connections made.

.16 All fire stop flaps, fire dampers, and smoke dampers are installed and checked for operation.

.17 All ducted supply/return/exhaust grilles are installed.

.18 All supply air, return air, exhaust air, outside air, and combustion air ductwork is installed and cleaned.

.19 All fire protection including sprinklers and fire extinguisher brackets are installed and operational.

.20 All plumbing fixtures are installed, solidly supported and in operation. Domestic water lines are flushed and disinfected.

.21 The building automation system seven (7) day acceptance test has been successfully completed.

.22 Noise and vibration control devices and flexible connections inspected by manufacturer’s representative and written report submitted.

.23 All necessary tests and start-up procedures on equipment have been made, including those required by authorities.

.24 All contractor system start-up and test sheets have been completed and submitted for review.

.25 Warranty forms have been mailed to manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one (1) year.

.26 Following information has been submitted:

.1 Final draft of O & M Manuals.

.2 Final certificates from authorities having jurisdiction.

.3 System cleaning reports.

.4 Reports from manufacturer on noise and vibration control devices.

.5 Completed record drawings.

.4 Identify any systems which cannot be installed and/or placed in operation for reasons beyond the normal control of the contractors and submit a statement of the value of the remaining work required to complete the project.

.5 Within ten (10) days of receipt of a written application for a "Certificate of Substantial Performance", the Engineer shall visit the site.

.6 If, after the Engineer's site visit the application for a "Certificate of Substantial Performance" is not approved, the contractor shall reapply in accordance with the Engineer's site visit report and pay for costs of re-inspection services.

1.35 Certificate Of Total Performance

.1 Comply with the requirements of Division 01.

.2 Prior to application for a statement of "Total Performance", the Contractor shall certify the following in writing to the Engineer:

.1 All items noted in previous site visit reports including that performed for Substantial Performance have been completed.

.2 All controls have been calibrated and set.

.3 Equipment cleaned inside, outside and lubricated.

.4 All equipment has been aligned by qualified millwrights.

.5 Plumbing fixtures and brass have been cleaned.

.6 Warranty forms are mailed to manufacturer. (Provide copy of original warranty for equipment which has a warranty period of longer than one year).

.7 Temporary filters are removed and permanent filters are installed.

.8 Completed and accepted Operating and Maintenance (O & M) Manuals have been submitted to Owner.

.9 Completed and accepted final air and water Balancing Reports have been included in the O & M Manuals.

.10 The Owner has received instructions in the operation and maintenance of the system.

.3 Within ten (10) days after receipt of a written application for a "Certificate of Total Performance", the Engineer shall visit the site.

.4 The Engineer shall provide one (1) visit for the purpose of reviewing the application for a "Certificate of Total Performance". Subsequent visit(s) if required, shall be at the expense of the contractor.

1.36 Contract Price Breakdown

.1 Submit a breakdown of the contract price using the following form within thirty (30) days of contract award and well before first progress claim for review and approval by Engineer.

.2 Progress claims shall be submitted using this contract price breakdown.

	MATERIAL	**LABOUR**
1. Bonding		
2. Supervision		
3. Project Overheads: Shack, Telephone, etc.		
4. Documentation		
5. System Demonstration and Owners Instruction		
6. Materials Testing		
7. Equipment Testing and Start-Up (Commissioning)		
8. Balancing		
9. Site Services		
• Municipality Charges for Site Services		
• Water - On Site		
• Sanitary - On Site		
• Gas Service		
10. Pre-operational Cleaning and Chemical Treatment		
11. Plumbing		
• Fixtures		

	MATERIAL	LABOUR
• Piping & Valves		
• Domestic Water Heaters		
• Pumps		
• Miscellaneous Equipment (List)		
• Tanks		
12. Heating		
• Piping & Valves		
• Gas Fired Unit Heaters		
• Electric Heaters		
• Miscellaneous Equipment (List)		
13. Ventilation & Air Conditioning		
• Air Handling Units		
• Make-up Air Units		
• Fans		
• Grilles & Diffusers		
• Computer Room Air Conditioning Units		
• Ducts and Dampers		
• Miscellaneous Equipment (List)		
14. Fire Protection		
• Sprinklers		
• Fire Extinguishers		
15. Insulation		
• Piping Insulation		
• Duct Insulation		
• Equipment Insulation		
16. Duct Cleaning		
17. Breeching & Chimneys		
18. Controls		

TOTAL (TO EQUAL CONTRACT PRICE)

2. Products

2.1 Operating and Maintenance Manuals

.1 Comply with Division 01:

.1 Closeout Procedures — Section 01 77 00

.2 Closeout Submittals — Section 01 78 00

.3 Building Management Manual — Section 01 91 51

.2 Binders

.1 Provide four (4) sets of Operations and Maintenance Manuals.

.2 Each set of manuals shall include as many binders as required to accommodate the project information.

.3 Binders shall be 216mm (8½”) x 280mm (11”), three (3) post, expanding spine type, with metal piano hinges and bound with heavy fabric.

.4 Maximum binder thickness when filled shall not exceed 100mm (4”), including a space allowance for 10% additional data.

.5 Binder color shall be blue, Ontario buckram fabric, color #OBV460.

.6 Project title and identification shall be silk screened on the front cover and spine. All lettering and borders shall be white.

.7 Binder spine identification to include Volume #, Set #, Title Description, Facility Name and Facility Location. Title of the project is to be as per title on drawings cover sheet.

.8 Contractor to submit proof of cover layout for review prior to ordering binders.

.9 In addition to the hard copies, an electronic version of the Operating and Maintenance manuals are to be provided in PDF on a CD.

.3 Tabs

.1 The divider tabs shall be laminated mylar plastic and colored according to division and section.

.2 Plastic tabs with typewritten card inserts will not be accepted.

.3 Each tab to include tab number and title printed on the tab.

.4 The coloring for tabs for individual sections is as follows:

Green:	Air Systems

Brown:	Control Systems
Blue:	Cooling Systems
Red:	Fire Protection
Orange:	Heating Systems
Yellow:	Miscellaneous Systems
Purple:	Plumbing Systems

.4 Manual Divisions

.1 Organize each manual into the following divisions.

.1 Operation Division

.2 Maintenance Division

.3 Contract Documentation Division

.5 Operations Division

.1 The operations division shall have all data organized into sections according to the system category with individual divider tabs as follows:

.1 AIR - Air Systems

.2 CTL - Control Systems

.3 CLG - Cooling Systems

.4 FPN - Fire Protection Systems

.5 HTG - Heating Systems

.6 MIS - Miscellaneous Systems

.7 PLG - Plumbing Systems

.2 Organize data for each system category (section) into individual sub-systems. Provide an index for each system category and a divider tab for each individual system.

.3 For each individual sub-system include the following:

.1 System Description - Provide details of system type, composition, areas served, location in the building, design criteria and function of major components. All equipment arranged to operate together as one system shall be considered part of that system description. Design criteria shall, at minimum, include the following:

.1 Occupied space conditions

.2 Outdoor ambient conditions

.3 Air circulation rate

.4 Exhaust air rate

.5 Minimum outside air

.6 Building pressurization

.7 Calculated load and design capacity of domestic water supply mains

.8 Calculated load and design capacity of drainage mains

.9 Hydraulic calculations

.10 Occupancy type and densities

.11 Water supply: static and dynamic pressures used for design

.12 Referenced design standard

.13 Future load allowances

.14 Standby capabilities

.2 System Schematics - Provide a system schematic showing all components comprising the central system. Identify each component using DDC system mnemonic and generic name designation. Use this equipment designation in all references to the equipment throughout the manual.

.1 System schematics shall include at a minimum:

.1 Ventilation systems

.2 Plug load systems

.3 Domestic hot/cold/recirculation water systems

.4 Fire protection systems

.3 Operating Instructions - Provide, in "operator" layman language, the specific instructions for start-up, shutdown and seasonal change over of each system component. Include exact type and specific location of each switch and device to be used in the system operation. Identify safety devices and interlocks that must be satisfied in order for the equipment to start. Also, list conditions to be fulfilled before attempting equipment start-up, i.e. valves position correct, glycol mixture concentration proper, piping filled with fluid, filters/strainers in place, etc.

.4 Maintenance Division

.1 Organize data into the following sections with divider tabs:

.1 Maintenance Tasks And Schedules

.2 Spare Parts

.3 Suppliers And Contractors

.4 TagsAnd Directories

.2 Maintenance Tasks and Schedules - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize maintenance tasks from manufacturers maintenance brochures, for each component of each system in the following format:

.1 Daily

.2 Weekly

.3 Monthly

.4 Semiannually

.5 Annually

.6 When Required.

.3 Spare Part List - Organize data according to the system category, with further breakdown into individual systems as used in the operations division of the manual. Provide section index and divider tabs for each system category. Summarize from manufacturers maintenance brochures the recommended spare parts for each component of each system.

.4 Suppliers and Contractor List - Provide summary of Suppliers and Contractors for each components of each system. List name, address and telephone number of each.

.5 Tags and Directories - Provide a copy of the Mechanical Drawing, List, Valve Tag List, Piping Identification Schedule and all other directories as specified in the contract documents.

.5 Contract Documentation Division

.1 Organize all data required by the construction contract into sections, with divider tabs, as follows:

.1 Drawings List

.2 Shop Drawings and Product Data

.3 Certifications

.4 Warranties and Bonds

.5 Maintenance Brochures

.6 Reports

.2 Shop Drawings and Product Data - Provide final copies of all shop drawings and product data required by the contract documents. Include section index and divider tabs. Maximum of twenty-five (25) sheets or one (1) system shop drawing per tab.

.3 Certifications - Provide copies of Contractor Certifications for the performance of product and systems. Include copies of all pressure tests for piping and ductwork systems, equipment alignment certificates, local authority inspection reviews, backflow prevention certification, and fire protection certifications. Include section index and divider tabs with maximum of twenty-five sheets (25) or one report per tab.

.4 Warranties and Bonds - Include one copy each of the Contractor's warranty, manufacturers' warranties longer than one year, the bond, and any service contract provided by the contractor. Provided section index.

.5 Maintenance Brochures - Include copies of all manufacturers' printed maintenance brochures pertaining to each product, equipment or system. provide section index and divider tabs. Maximum of twenty-five (25) sheets or one system brochure per tab.

.6 Reports - Include copies of all reports relating to the testing, adjusting and balancing of equipment and systems, water treatment reports and manufacturer’s start-up reports, as required by the contract specification sections.

.6 Submissions and Approvals

.1 First Draft Submission

.1 Contractor shall submit a draft copy of the operations and maintenance manuals for format review at the 50% construction completion stage.

.2 The draft submission is to be bound in 3 ring loose leaf type binders and shall include the following information:

.1 A table of contents for the complete manual.

.2 Index of each division of the manual.

.3 Index of each section of the operations and maintenance divisions.

.4 A sample operations division write-up for a typical system, including sample schematic.

.5 A sample maintenance division write-up for the same typical system.

.6 Sample proof of binder covers and spines.

.3 On completion of review of the first draft submission the consultant will return the copy of the manual with review comments for resubmission.

.2 Provisional Edition

.1 The contractor shall submit two (2) copies of the provisional edition of the manual at the 75% construction completion stage.

.2 The provisional edition shall be complete in all respects, except for reports and certificates to be produced during the facility start-up phase. This manual shall have the same physical format, including divider tabs and indices, as the final edition of the manual. This provisional edition may be bound in standard three-ring loose leaf binders.

.3 One copy of the provisional edition shall be kept on site as an interim reference for all parties engaged in the facility start-up phase, and shall be used to familiarize and train the operating staff.

.4 The second copy shall be returned to the contractor with review comments.

.5 The contractor shall update contents of the site copy of the provisional edition manual as new information is generated during the facility start-up phase.

.3 Final Edition

.1 Prior to final acceptance the contractor shall submit four (4) copies of the final edition of the manual.

.2 This final edition shall include all outstanding project information and conform to all requirements listed in this document.

3. Execution

3.1 Demonstrations – General

.1 Mechanical Trade shall arrange for presentation and demonstration of HVAC, plumbing and fire suppression equipment and systems by appropriate specialists and shall ensure that required manufacturer's representatives are in attendance.

.2 Coordinate demonstration and instruction agenda and schedule with the Owner and Engineer.

.3 Coordinate demonstration and instruction agenda and schedule for work performed outside the contract with the owner and engineer.

.4 Provide personnel when necessary to ensure proper detailed training is provided for all mechanical systems.

.5 Do not commence the instructional period until all mechanical systems are complete and proven operational.

.6 Include in the operating and maintenance manuals all instructions and information given to owner’s staff and instructions and information given by equipment manufacturer’s representatives.

3.2 Demonstrations – Equipment & Systems

.1 Demonstrate specific starting and stopping and general maintenance requirements for each major piece of equipment. Ensure all labeling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Air Systems

.2 Control Systems

.3 Balancing

.4 Plumbing Systems

.5 Fire Protection Systems

.3 Demonstrate the following pieces of equipment.

.1 Fans/Air Handling Units

.2 Unit Heaters

.3 Unitary Air Conditioners

.4 Domestic Water Heaters

.5 Domestic Water Recirculation Pumps

.6 Sprinkler Valve Assemblies

.7 Dry Sprinkler Systems

.4 Refer to sample mechanical system agenda schedules in section 3.3 following for identifying the proposed sequence of demonstrations. Sequence of demonstration and duration of training seminars to suit project. Submit agenda for review by Engineer one month prior to demonstration.

.5 Answer all questions raised by Owner at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

.6 Provide sign off sheets for each session. Sign off sheets to have attendees, date, subject, presentation by and comments. Attach the sign off sheets to the agenda and submit a copy to the engineer following training seminars.

3.3 Mechanical Systems Agenda (Sample)

Mechanical Systems Agenda

Topic: Heating System

Day: 1. Start Time: 8:00 am
2. Meeting Place: ______________

Approximate Duration: 7.5 hours

Agenda: 1. 8:00am – Classroom Presentation
2. Contractor / Supplier: ______________

Lunch Break: 12:00pm to 1:00pm

Agenda: 1. 1:00pm – Site Walkthrough
2. 4:00pm – Final Questions and Sign-off Log Sheet

Personnel to be in Attendance:

1. Mechanical Contractor and Sub-Trades (as required)

2. Maintenance Staff

Presentation Format:

Classroom:

Introduction:

1. Pass out hand-outs of system description
2. Reference to equipment operation brochures as required
3. Detailed system overview by Mechanical Trade, Sub-Trades and Suppliers
4. Review of system installations by the Mechanical Trades using record drawings

Site Tour:

1. Mechanical Trade to outline location of main piping runs, isolation valves, service access points.
2. Review service procedures for heating boiler and circulation pumps.
3. Terminal hot water heating units to be reviewed for service and operation.
4. Coils, expansion tanks and accessories to be reviewed for service and operation.
5. Equipment to be reviewed and dismantled as required to demonstrate servicing.
6. Gas Fired equipment to be reviewed and dismantled as required to demonstrate servicing and operation.
7. Provide written instructions on how to start and stop all equipment and demonstrate using instructions during tour.

3.4 HVAC Equipment Testing and Startup – General

.1 Conduct performance tests to demonstrate equipment and systems meet specified requirements after mechanical installations are completed and pressure tested. Conduct tests as soon as conditions permit. Make changes, repairs, and adjustments required prior to operating tests.

.2 Meet with Division 26 manufacturers, suppliers, and other specialists as required to ensure all phases of work are properly coordinated prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.

.3 Gas fired appliances rated in excess of 17 kW (400 MBH) shall be subjected to an operational test established by the Gas Protection Branch and shall pass this test before being approved for operation.

.4 Operate and test motors and speed switches for correct wiring and sequences and direction of rotation. Check and record overload heaters in motor starters.

.5 Confirm voltages and operating amperages at full load.

.6 Tests to be maintained for a period of eight (8) hours minimum for each system. Test for air and water flow and temperature and humidity to demonstrate compliance with design requirements.

.7 During test, make adjustments to bring equipment up to the required standards with respect to performance, vibration, noise, etc.

.8 Conduct final operating tests in presence of the owner. Vary loads to illustrate start-up and shut down sequence and simulate emergency conditions for safety shut downs, with automatic and manual reset. Repair and test defects until satisfactory. Make final adjustments to suit exact building conditions.

.9 Provide services of one job mechanic, ladders, tools and associated equipment required to assist in final tests. Owner's personnel may witness all tests.

.10 Lubricate bearings, adjust and/or replace and set direct and 'V' belt drives for proper alignment and tension.

.11 Calibrate and adjust thermostats, thermometers and gauges. Control valves shall operate freely.

.12 Operate and test motors for correct wiring and sequences. Check overload heaters in motor starters are within the constraints of Division 26 requirements. Replace heaters if required to suit as installed condition.

.13 Remove and clean strainers.

.14 Fasten loose and rattling pieces of equipment. Pumps and other equipment shall operate quietly.

.15 Failure to follow instructions pertaining to correct starting procedures may result in re-evaluation of equipment by an Independent Testing Agency selected by Owner at Contractor's expense. Should results reveal equipment has not been properly started, equipment may be rejected, removed from site, and replaced. Replacement equipment shall also be subject to full starting procedures, using same procedures specified on the originally installed equipment.

3.5 HVAC Equipment Testing and Startup – Procedures

.1 Procedure shall be identified in the following five (5) distinct phases:

.1 Pre-Starting: Visual inspection.

.2 Starting: Actual starting procedure.

.3 Post-Starting: Operational testing, adjusting or balancing, and equipment run-in phase.

.4 Pre-Interim Acceptance of the Work: Final cleaning, re-testing, balancing and adjusting, and necessary maintenance.

.5 Post-Interim Acceptance of the Work: Repeat tests and fine-tuning resulting from corrective action of deficiency clean-up.

.2 Check specified and shop drawing data against installed data.

.3 Check the installation is as defined by contract documents and as per manufacturer's recommendations including manufacturer's installation check sheets.

.4 Include for the costs of an independent testing agency, selected by the Owner, to take samples of all chemically treated hydronic systems, perform lab analysis of the chemical treatment levels, and submit a written report of their findings to the Owner. Should chemical treatment levels not meet the requirements of the specifications, the Contractor shall adjust treatment levels accordingly and cover the costs of the independent testing agency to take additional samples and tests.

3.6 HVAC Equipment Testing and Startup – Contractor Testing Responsibilities

.1 The contractor shall be required to provide the following tests as part of his construction contract. For each test, a test form is to be filled out, witnessed, kept on site for the consultant to verify at any time during construction and then they are to be included in the final submission of the contractor O & M manuals.

.1 Sprinkler Systems

.1 Record incoming water pressure to building once a day for 10 days

.2 Record flow and pressure for fire pump and jockey pump, along with inlet water pressure

.3 Test sprinkler system as per NFPA 13

.2 Fire Extinguishers

.1 Check that no pressure drop occurs over a 20 day period

.3 Plumbing Systems

.1 Piping

.1 Test as per the requirements of the National Plumbing Code 2010.

.2 Domestic Hot Water Recirculating Pumps

.1 Perform load tests on pumps and record pressures and flows throughout the building

.2 Verify proper sequencing and control of staged pumps

.3 Record motor power consumption at peak flows

.4 Air Systems

.1 Fans

.1 Check radiated and discharge sound power levels

.2 Determine rpm, air flow rates, static pressure and record on the fan curves

.3 Conduct fan performance test for total system volume on main air supply and exhaust units

.4 Conduct smoke control test to meet occupancy requirements

.5 prove cleanliness of duct work and air flow patterns.

.2 Air Outlets

.1 Take sound readings at specified air flows at outlets

.2 Operating room outlets to be tested as per Class I Microbiology Clean Air Act.

.3 Fire Dampers

.1 Test each damper to ensure proper blade movement and damper closure

.2 Verify damper accessibility for changing of the fusible links

.4 Ductwork

.1 Low pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 05 07.

.2 Medium and high pressure supply, return and exhaust ductwork is to be pressure tested as per requirements of Section 23 05 07.

.5 Packaged A/C Units

.1 Check unit is level

.2 Measure air flow and static pressure

.3 Entering dry bulb/wet bulb temp.

.4 Leaving dry bulb/wet bulb temp.

.5 Entering water temp.

.6 Leaving water temp.

.7 Water flow rates

.8 Acoustic measurements

.6 Unit Heater

.1 Inlet/outlet air flows and temp.

.2 Inlet/outlet water flows and temp.

.3 Air and water pressure drop across the unit

.4 Fan speed setting

.5 Check acoustic performance

.5 DDC Control System

.1 General

.1 Conduct system 7 day performance test to prove communication, loop tuning and control sequences

END OF SECTION

1. General

1.1 Scope

.1 This section covers general motor requirements for factory and field installed motors.

.2 Refer to individual sections for application of motors and reference to specific motor requirements for motor driven equipment.

.3 Motors shall be suitable for horizontal, vertical or belt driven mounting.

1.2 Submittals

.1 Submit shop drawings for motor driven equipment, as required by equipment specification sections. Motor shop drawing information shall include, but not be limited to the following:

- .1 Voltage/Phase./Hertz
- .2 Motor power (kW or Watts)
- .3 Full load amps
- .4 Wiring diagrams (as required)

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related Work Specified in Other Sections

.1 Refer to and comply with the following sections:

.1	Domestic Water Pumps	Section 22 11 23
.2	Common Work Results for HVAC	Section 23 05 00
.3	HVAC Fans	Section 23 34 00
.4	Fuel Fired Unit Heaters	Section 23 55 33
.5	Packaged Outdoor Central Station Air Handling Units	Section 23 74 13
.6	Packaged Indirect Fired Make-Up Air Units	Section 23 74 23.16
.7	Split System Air Conditioners	Section 23 81 26

.8 Electrical Division 26

1.6 Standards

.1 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards:

.1 National Electrical Manufacturers Association (NEMA)

.2 Electrical Equipment Manufacturers Association of Canada (EEMAC)

.3 Canadian Standards Association (CSA)

.4 Canadian Electrical Code (CEC) Part 1

.5 Institute of Electrical and Electronic Engineers (IEEE)

.6 American National Standards Institute (ANSI)

1.7 Quality Assurance

.1 All motors shall be ULC listed and CSA certified.

.2 All motors to be approved for use in the designated area classification by the Electrical Protection Branch, Alberta Department of Labor.

.3 Full Voltage Start Applications:

.1 All motors shall be in accordance with NEMA standards, and CSA C390-93, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.4 Variable Frequency Drive and Soft Start Applications:

.1 Where equipment is noted to be controlled by a VFD on the equipment schedules, or in other Sections, the motors shall be in accordance with NEMA standards (MG-1) Part 31, and inverter duty class, or the latest version insofar as it is applicable. Motors also shall comply with the applicable portions of the Canadian Electrical Code.

.2 Motors connected to VFD(s) shall be wound using inverter spike resistant magnet wire capable of 1600V.

1.8 Testing

.1 Production Tests: Each motor shall receive a routine commercial test per NEMA MG-1.12. Prototype test reports shall be for each rating.

.2 Sound Level: The noise level of each motor shall comply with NEMA MG-1.12.49.

.3 Vibration Level: The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.

1.9 Variable Speed Drives

.1 Motors shall be designed for operation with Variable Frequency Drives as noted on the motor schedule.

2. Products

1.1 General Requirements

.1 Provide motors for mechanical equipment as specified.

.2 Unless noted otherwise, provide open drip-proof, ball or roller bearing motors with grease fittings.

.3 Motors shall have standard voltage ratings consistent with the project distribution voltages.

  .1 Motors 0.372 kW (½ HP) and less to be 120 volt, 60 cycle, single-phase power.

  .2 Motors 0.559 kW (¾ HP) and larger to be 3 phase power and for the scheduled voltage.

  .3 Confirm electric voltage, phase and starter requirements with the electrical specifications.

  .4 Refer to equipment schedules on drawings.

.4 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.5 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.6 Provide all motors with terminal boxes, suitable for power connections.

.7 Provide screw adjustable bases on all belt-connected motors.

.8 Motors shall be of the capacitor start type when they may be manually cycled from a starting switch which is located in the finished space.

.9 Motors exposed to outdoor temperature to be lubricated with lubricants suitable for operation at 6°C below the lowest temperature recorded by ASHRAE or the Climatic Information (Supplement to the National Building Code), for the location in which they are installed.

.10 Refer to electrical specifications for voltage, frequency, and phase data. This shall take precedence over any reference in Division 23. Packaged equipment shall have connections as specified in Division 26.

.11 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

1.2 Voltage and Frequency

.1 Motors will be rated for operation on a 1-phase or 3-phase, 60 Hz power supply at 115 Volts, 208 Volts or 575 Volts. All motors shall be designed and manufactured to operate with ±10% voltage and ±5% frequency variations of the nameplate ratings. Combined voltage and frequency variation shall not exceed ±10%. Confirm voltage for all motors with Division 26.

1.3 Torque

.1 Motors shall meet or exceed the locked rotor (starting) and minimum breakdown torques specified in NEMA standard for Design B for the ratings specified.

1.4 Current

.1 Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to the motor components.

1.5 Efficiency

.1 Motors shall be Premium Efficient design and have a minimum and nominal full load efficiency which will meet or exceed the values listed in NEMA MG1-12.55 Table 12-6B when tested in accordance with NEMA test standard MG1-12.54.1, IEEE Test Procedure 112, Method B using accuracy improvement by segregated loss determination including stray load loss measurements. The minimum efficiency shall be guaranteed.

.1 Premium efficiency open drip-proof motors shall have the following typical full load efficiencies (nominal):

kW (HP)	**Premium Efficiency - Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	84.0	84.0
1.49 (2)	82.5	84.0	85.5
2.24 (3)	82.5	87.5	86.5
3.73 (5)	84.0	87.5	87.5
5.59 (7.5)	86.5	89.5	88.5
7.46 (10)	87.5	90.2	90.2

kW (HP)	**Premium Efficiency - Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
11.2 (15)	88.5	91.7	90.2
14.9 (20)	89.5	91.7	91.0
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	93.0	92.4
29.8 (40)	91.0	93.0	93.0
37.3 (50)	91.7	93.6	93.0
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.1	93.6
74.6 (100)	92.4	94.5	94.1
93.2 (125)	93.0	94.5	94.1
111.9 (150)	93.0	95.0	94.5

.2 Premium efficiency totally enclosed fan cooled motors shall have the following typical full load efficiencies (nominal).

kW (HP)	**Premium Efficiency - Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
0.746 (1)	74.0	82.5	80.0
1.12 (1.5)	81.5	94.0	85.5
1.49 (2)	82.5	94.0	86.5
2.24 (3)	84.0	87.5	87.5
3.73 (5)	86.5	87.5	87.5
5.59 (7.5)	87.5	90.2	89.5
7.46 (10)	88.5	90.2	89.5
11.2 (15)	89.5	91.0	90.2
14.9 (20)	89.5	91.7	90.2
18.6 (25)	90.2	92.4	91.7
22.4 (30)	90.2	92.4	91.7
29.8 (40)	91.0	93.0	93.0

kW (HP)	**Premium Efficiency - Minimum Efficiency (%)**		
	3600 RPM 2 Pole	**1800 RPM 4 Pole**	**1200 RPM 6 Pole**
37.3 (50)	91.7	93.6	93.0
44.7 (60)	92.4	94.1	93.6
55.9 (75)	92.4	94.5	93.6
74.6 (100)	93.0	94.5	94.1
93.2 (125)	94.1	94.5	94.1
111.9 (150)	94.1	95.0	95.0

1.6 Sound Level

.1 The noise level of each motor shall comply with NEMA MG-1.12.49.

1.7 Vibration Level

.1 The vibration level of each motor shall not exceed those values listed in NEMA MG-1.12.05.

1.8 Service Factor and Ambient

.1 Standard motors shall be rated for a 1.15 service factor in a 40°C (104°F) ambient unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection. Motors 30 kW (40 hp) and larger shall have thermistor protection.

1.9 Insulation

.1 Standard motors shall have a full Class F non-hygroscopic insulation system.

.2 Standard motors shall be dipped and baked in a non-hygroscopic polyester high temperature varnish, spike resistant for motors connected to VFDs and soft-starts (NEMA MG-1 Part 31).

.3 Moisture resistant (MR) copper magnet wire rated for 200°C (392°F) or better.

1.10 Nameplates

.1 Nameplates shall be of stainless steel and stamped per NEMA Standard MG1-10.40. Nameplate information shall include the nominal efficiency value per standard MG1-12.54.2.

1.11 Belt Drives

.1 Provide belt drives to the following requirements:

.1 Provide steel, cast iron or aluminum sheaves for motors less than 0.559 kW (3/4 HP).

.2 Provide steel or cast iron sheaves keyed to shafts, for motors 0.559 kW (3/4 HP) and larger.

.3 For motors less than 7.46 kW (10 HP) provide standard adjustable pitch drive sheaves having +/-10% range. Use mid-position of range for specified RPM.

.4 For motors 7.46 kW (10 HP) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.

.2 Match drive and driven sheaves.

.3 V-belts shall conform to the American Belt Manufacturers standards. Multiple belts shall be matched sets.

.4 Not less than a 2-belt configuration is required for each drive for motors 0.559 kW (3/4 HP) and larger.

3. Execution

1.1 General

.1 Unless otherwise noted starters and protection devices will be included under the Electrical Division of the Specification.

.2 Assist Division 26 to ensure proper connection, correct thermal overload protection and correct motor controls.

.3 Where starters are included in this Division as an integral part of packaged equipment, they shall contain thermal overload protection in all ungrounded lines.

.4 Equipment, which has more than one voltage rating, shall be fed from a single power source through a disconnect switch.

.5 If delivery of specified motor will delay delivery or installation of any equipment, install an acceptable motor for temporary use. Final acceptance of equipment will not be given until specified motor is installed.

1.2 Setting and Alignment

.1 Employ a journeyman millwright to align all V-belt drives and/or shaft coupling drives prior to initial start-up. The millwright shall also check that centrifugal fan wheels are properly centered on fan shafts.

.2 Align shaft couplings, using a dial indicator, to within +/-0.051 mm (0.002") after grouting is complete and the piping system is operational.

.3 Align V-belt drives using a straight edge.

.4 Submit a certificate from the millwright employed, certifying that all shaft couplings and V-belt drives have been aligned and centrifugal fan wheels centered prior to initial start-up and checked again after final system balance adjustment.

END OF SECTION

1. General

1.1 Scope

.1 Gate valves

.2 Globe or angle valves

.3 Ball valves

.4 Butterfly valves

.5 Check valves

.6 Plug valves

.7 Drain valves

.8 Circuit balancing valves

.9 Strainers

1.2 Reference Documents

.1 American Society for Testing and Materials (ASTM):

- .1 ASTM A126-04 — Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
- .2 ASTM B21/B21M-06 — Standard Specification for Naval Brass Rod, Bar, and Shapes
- .3 ASTM B61-08 — Standard Specification for Steam or Valve Bronze Castings
- .4 ASTM B62-09 — Standard Specification for Composition Bronze or Ounce Metal Castings
- .5 ASTM B98/B98M-08 — Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes
- .6 ASTM B139/B139M-07 — Standard Specification for Phosphor Bronze Rod, Bar, and Shapes

.2 Canadian Standards Association (CSA):

- .1 CSA B149.1-05 Natural Gas and Propane Installation Code

.3 National Plumbing Code 2010

.4 National Fire Protection Association (NFPA):

.1 NFPA 13-2010 Standard for the Installation of Sprinkler Systems

.5 Manufacturers Standardization Society Standard Practices (Current Editions)

.1 SP-67 Butterfly Valves

.2 SP-70 Gray Iron Gate Valves, Flanged and Threaded Ends

.3 SP-71 Gray Iron Swing Check Valves, Flanged and Threaded Ends

.4 SP-80 Bronze Gate, Globe, Angle, and Check Valves

.5 SP-82 Valve Pressure Testing Methods

.6 SP-110 Ball Valves, Threaded Socket-Welding, Solder Joint, Grooved and Flared Ends

1.3 Manufacturer

.1 Provide valves of the same type by the same manufacturer throughout.

.2 Valves shall bear the following information permanently marked on the valve body”

.1 Manufacturer’s name or trademark

.2 Pressure rating

.3 Flow direction

.3 Valves for fire protection service to be ULC Listed and FM Approved.

1.4 Shop Drawings

.1 Submit detailed shop drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. Products

2.1 Acceptable Manufacturers

1. Gate Valves : Crane, Jenkins, Kitz,Nibco, Toyo
2. Globe Valves : Crane, Jenkins, Kitz, Milwaukee, Nibco, Toyo
3. Angle Valves : Crane, Jenkins, Kitz, Milwaukee, Nibco, Toyo
4. Swing Check Valves : Crane, Jenkins, Kitz, Milwaukee, Moygro, Mueller, Nibco, Toyo

5.	Silent Check Valves	:	APCO, Duo-Check, Mueller,Stream Flo, Val-Matic
6.	Ball Valves	:	Crane, Jenkins, Kitz,MAS, Milwaukee, Nibco, Toyo
7.	Plug Valves	:	DeZurik, Flowserve, Homestead, Milliken
8.	Butterfly Valves	:	Apollo, Bray, Center Line, DeZurik, Jenkins, Keystone, Kitz, Milwaukee, Mueller, Nibco, Toyo
9.	Drain Valves	:	Crane, Dahl, Hammond, Jenkins, Kitz, Nibco, Toyo
10.	Circuit Balancing Valves	:	Armstrong, Bell & Gossett, Nibco, Tour and Anderson
11.	Strainers	:	Crane, Kitz, Hoffman, Mueller Steam, Nibco, SpiraxSarco, Toyo, Watts, Victaulic

2.2 Fire Protection System

.1 Gate Valves

.1 Up to 50mm (2”): Bronze body, threaded ends, Outside Screw and Yoke (O.S.Y.), rising stem, screw-over or screw-in bonnet, solid wedge, rating 1205 kPa (175 psi) water, ULC Listed& FM Approved.

Standard of Acceptance: NibcoT-104-O

.2 65mm (2½”) and Over: Cast iron body, flanged ends, O. S.Y., rising stem, bronze trim, solid wedge, wheel handle; rating 1205 kPa (175 psi) water; ULC Listed& FM Approved.

Standard of Acceptance: Nibco F-607-OTS

.3 Underground: Cast iron body, mechanical joint or flanged ends, inside screw, non-rising stem, bronze trim, solid wedge, square operating nut; rating rating1380 kPa (200 psi) water;Underwriters listed. Indicator post operator, Underwriters listed.

.2 Butterfly Valves:

.1 FM and ULC approved, cast iron lug-wafer body, bronze disc, BUNA-N liner; 1380 kPa (200 psi) at 68°C (155°F).

Standard of Acceptance: Jenkins Figure 2232 BUJ

.2 Grooved:

.1 Ductile iron, EPDM encapsulated ductile iron disc, stainless steel stem with metal bushings

.2 Rating: 300 psi WWP

.3 Valve shall accept internal supervisory switches

.4 ULC Listed and FM Approved

.3 Swing Check Valves

.1 Up to 50mm (2”): Bronze body threaded ends, screw-in cap, renewable composition disc rating 2070 kPa (300 psi) W.O.G.

Standard of Acceptance: Jenkins Figure 4475J, Milwaulkee #510.

.2 65mm (2½”) and Over: Cast iron body, flanged ends, bolted cover, regrind-renew bronze disc and seat ring, rating 1205 kPa (175 psi) water. Underwriters listed.

Standard of Acceptance: Jenkins figure 477.

.3 Check valves serving Siamese connections provided with rubber faced disc.

Standard of Acceptance: Jenkins Figure 477J; Nibco F-908-W

.4 All operable valves are to be complete with supervisory switches.

2.3 <u>Domestic Cold Water System</u>

.1 Globe Valves

.1 Up to 50mm (2”): Bronze body, screw over bonnet, threaded ends rating 1035kPa (150psi) steam, solder ends; rating 2070 kPa (300 psi) water.

Standard of Acceptance: Jenkins Figure 106-BJ, Figure 106-BPJ, Crane #7TF, Toyo #221, Kitz #09, Kitz #10.

.2 65mm (2½”) and Over: Cast iron body, flanged ends, O.S. and Y, renewable bronze seat ring, fully guided bronze disc; rating 860 kPa (125 psi) steam.

Standard of Acceptance: Jenkins Figure 2342J, Crane #351, Toyo #400A, Kitz #76.

.2 Ball Valves

.1 Up to 50mm (2”): Two piece bronze body, full standard port, chrome plated, solid bronze ball, threaded or solder ends, TFE seat and packing, level handle; rating
4134 kPa (600 psi) non-shock W.O.G.

Standard of Acceptance: Jenkins Figure 901J, Toyo #5044A, Toyo #5049A, Kitz #58, Kitz #59.

.3 Butterfly Valves:

.1 Cast iron wafer full-lug body, Stainless steel shaft keyed to disk, aluminum bronze disc, EPDM rubber seat and seals, lever lock handle operator with multiple position lock plate for valve sizes to 100mm (4”), heavy duty gear handwheel operator with position indicator for valve sizes 150mm (6”) and over. Minimum bi-directional rating: 1380 kPa (200 psi) non-shock cold water working pressure. Full rating for end of line or isolation shut off service.

Standard of Acceptance: NIBCO LC2000

.4 Swing Check Valves

.1 Up to 50mm (2”): Bronze body screw-in cap, renewable no. 125 composition disc, threaded ends 860 kPa (125 psi) steam.

Standard of Acceptance: Jenkins Figure 4475J, Toyo #236T.

.2 65mm (2½”) and Over: Cast iron body, regrind-renew swing check, bolted cover, flanged or grooved ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam.

Standard of Acceptance: Jenkins Figure 587J, Kitz #78, Toyo #435A, Kitz #78, Victaulic #716.

.5 Silent Check Valves for Pump Discharge:

.1 Up to 50mm (2”): Bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends; rating 1380 kPa (200 psi) water.

Standard of Acceptance: Val Matic VM-S1400.

.2 65mm (2½”) and Over: Wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125.

Standard of Acceptance: Val Matic, Series 1400, Moyes& Groves W12A-I6V, Centerline Series 800

.6 Drain Valves:

.1 Drain Valves Up to 50mm (2”): Forged brass body, brass cap, stem, and ball; Teflon stem seals and Teflon seat; hose thread end; working pressure 1725 kPa (250 psi) at 121°C (250°F).

Standard of Acceptance: Dahl 50.430, Jenkins Fig 901CJ, Toyo #5046, Kitz #68AC.

.2 Drain Valves 65mm (2½”) and Over: Bronze body, bronze ball, threaded ends, twin seal Teflon seats and Viton seals, "O" ring, lever handle;rating 2070 kPa (300 psi) water at 121°C (250°F).

Standard of Acceptance: Jenkins Figure 32BJ.

2.4 Domestic Hot Water System

.1 Valves to be used in the hot water section of the system shall be exactly as specified in the cold water section with one exception, that all composition disc valves shall be fitted with discs suitable for hot water, rated for 2756 kPa (400 psi) at 94°C (200°F).

2.5 Domestic Hot Water Recirculating System

.1 Circuit Balancing Valves: Suitable for throttling; all metal parts non-ferrous, die cast non porous copper alloy;flow measuring accuracy ±2%; positive shut-off, drain connection with cap; memory balancing feature; fittings for connection of portable differential pressure meter.

Standard of Acceptance: Tour and Anderson, Bell & Gossett circuit setter.

2.6 Natural Gas Systems

.1 Plug Cocks:

.1 Class 125 non-lubricated parallel-plug valve, cast iron body and plug, short pattern, regular port, full bore, threaded or flanged ends, CGA approved. Valves installed outdoors shall be rated for operation down to -40°C (-40°F).

.2 Ball Valves:

.1 50mm (2”) and Smaller: CGA approved, -40°C (-40°F), full bore.

Standard of Acceptance: Toyo #5044A, Kitz #58, MAS B3.

.3 Pressure Regulator

.1 Direct-operated gas pressure regulator; cast iron body.Size regulator for full gas load to reduce gas pressure as shown on drawings.

Standard of Acceptance: Fisher

2.7 Valve Operators

.1 Provide suitable hand wheels for gate, globe or angle, radiation and drain valves.

.2 Provide one plug cock wrench for every ten plug cocks sized 50mm (2”) and smaller, minimum of one. Provide each plug cock sized 65mm (2½”) and larger with a wrench, with set screw.

.3 Provide latch lock throttling handle for butterfly valves 150mm (6”) and smaller and gear operators for 200mm (8”) and larger.

3. Execution

3.1 Installation and Application

.1 Install valves with stem upright or horizontal. Under no circumstances shall the stems be installed inverted.

.2 Align valve for easy access and identification when several service lines are installed together.

.3 Use line size throughout with the exception of control valve bypasses. Size control valve bypass valves equal to control valve.

.4 Install valves for shut-off and isolating service, to isolate all equipment, parts of systems, or vertical risers.

.5 Locate valves on the main side of the unions or flanges of the equipment. For heat transfer equipment valving, refer to drawings and section 3.2 – Valve Schedule below.

.6 Furnish extended shafts on butterfly valves when valves are to be insulated.

.7 Where butterfly valves are installed, provide threaded lug type valves on flanged systems. Victaulic connections where approved.

.8 Provide drain valves at main shut-off valves, low points of piping, and equipment and terminal units.

.9 Size drain lines and drain valves equal to size of equipment drain connection.

.10 For pipe size 20mm (¾”) and over, minimum drain size to be 20mm (¾”). Provide hose thread connection cap and chain for drain valves not piped directly to floor drains or where located in ceilings or public areas.

.11 Provide a valved drain and hose connection off the bottom of all strainers.

.12 Provide to the owner at project completion, one pressure differential flow meter where circuit balancing valves are specified and installed.

.13 Use temporary strainers during construction and system cleaning. Remove temporary and install permanent strainers prior to system balancing.

3.2 Valve Schedule

.1 Provide valves as indicated on drawings and the following schedule:

- .1 Gate Valves:
  - .1 Shut-off
  - .2 Isolating Service -Isolate equipment and vertical risers

.3 Branch take-offs& vertical risers (where indicated on drawings)

.2 Globe and Angle Globe Valves:

.1 Throttling service

.2 Control device

.3 Meter bypass

.3 Ball and Quick Opening Valves:

.1 Interchangeable with gate and globe valves

.2 Low water cut-offs

.3 Branch take-offs & vertical risers (where indicated on drawings)

.4 Isolating Service

.4 Butterfly Valves:

.1 Interchangeable with gate and globe valves in water systems only

.5 Swing Check Valves:

.1 Discharge of pumps

.2 Backflow prevention

.6 Circuit Balancing Valves:

.1 Domestic hot water recirculation

.7 Non-Lubricated Plug Cocks:

.1 Gas service

.2 Balancing service where shut-off or isolating valve is also provided

.8 Drain Valves:

.1 Near main shut-off valves

.2 Low points in piping systems

.3 Bases or vertical risers

.4 At equipment

END OF SECTION

1. General

1.1 Scope

.1 Pipe hangers and supports

.2 Duct hangers and supports

.3 Flashing for mechanical equipment

.4 Sleeving for mechanical equipment

.5 Equipment bases and supports

.6 Pipe anchors

.7 Access Doors

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of ANSI B31.1 Power Piping.

.2 Duct hangers shall conform to SMACNA Duct Manuals.

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

1.3 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction.

.2 Install supports of strength and rigidity to suit loading without unduly stressing the building. Locate adjacent to equipment to prevent undue stresses in piping and equipment. Where support is from concrete construction, avoid weakening concrete or penetrating waterproofing.

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

.4 Fasten supports and hangers to building structure. Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical. When possible, set inserts in position in advance of concrete work. Drill concrete where inserts must be placed after concrete is poured.

.5 Where structural bearings do not exist or where inserts are not in suitable locations for proper installation of pipes, conduits and ducts, provide approved support made of steel channels or angles from which to suspend hangers. Do not use existing piping, crane rails, trolley beams, mono rails, etc, for support.

.6 No percussion type fastening of any kind will be permitted without prior approval.

.7 Provide and set sleeves or block-outs required for equipment, including openings required for placing equipment.

.8 Provide sleeves for all piping through rated assemblies. In non-rated assemblies, provide sleeves for all natural gas, domestic cold, and domestic recirculation piping. Sleeves to be sized to allow insulation to pass through and to project through both sides of wall.

.9 Provide sleeves for all piping through ceilings, floors and footings.

.10 Provide sleeves for duct penetrations through walls, ceilings, floors and footings. Provide locations and dimensions for block-outs imbedded material if provided by others.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the structural engineer.

.12 Obtain approval prior to drilling for inserts and supports for piping system. Discuss and obtain approval for hanging systems and methods with Structural Engineer.

.13 Obtain approval prior to using percussion type fastenings.

.14 Use of piping or equipment for hanger supports and use of perforated band iron, wire or chain as hangers is not permitted.

1.4 Submittals

.1 Submit shop drawings for access doors.

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. **Products**

2.1 Acceptable Manufacturers

1. Pipe Hangers: Anvil, Cooper B-Line, Crane
2. Access Doors: Acudor, Maxam, Mifab, Milcor, Williams Brothers

2.2 Inserts

.1 Provide inserts to cast in concrete of malleable cast iron or galvanized steel and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Furnish self-drilling expansion shell for poured-in-place concrete if the concrete is set. Under no circumstances will Ramset pins or other explosive type pins be allowed.

.3 Size inserts to suit threaded hanger rods.

2.3 Pipe Hangers and Supports

.1 Hangers for steel piping systems:

Service	**Hanger Type**	**Material**	**Finish**
1. Nominal pipe size 12mm to 50mm:			
All services	Adjustable ring	Carbon steel	Black, prime coated
2. Nominal pipe size 50mm to 100mm:			
All services	Adjustable clevis (heavy duty)	Carbon steel	Black, prime coated
3. Nominal pipe size 150mm and larger:			
Hot piping	Adjustable steel yoke pipe roll	Cast iron roll, carbon steel yoke, roll rod and hex nuts	Black, prime coated
4. Nominal pipe size 150mm and larger:			
Cold piping	Adjustable clevis (heavy duty)	Carbon steel	Black, prime coated

.2 Hangers for copper and special material piping systems:

Service	**Hanger Type**	**Material**	**Finish**
1. Nominal pipe size 15mm to 50mm:			
All services	Adjustable ring	Carbon steel	Copper plated
2. Nominal pipe size 50mm to 100mm:			
All services	Adjustable ring	Carbon steel	Copper plated

.3 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods. Cast iron roll and stand for hot pipe sizes 150mm (6”) and over. Cup washers for hot piping below 150mm (6”).

.4 Wall Support, Pipe Sizes to 75mm (3”): Cast iron hook.

.5 Wall Support, Pipe Sizes 100mm (4”) and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150mm (6”) and over.

.6 Vertical Support: Steel riser clamp.

.7 Floor Support, Pipe Sizes to 100mm (4”) and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier or steel support.

.8 Floor Support, Hot Pipe Sizes 125mm (5”) and Over: Adjustable cast iron roll and stand, steel screws and concrete pier to steel support.

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

.10 Provide copper plated hangers and supports for copper piping.

.11 Provide galvanized hangers and supports for galvanized piping.

2.4 Hanger Rods

.1 Provide galvanized rods, threaded both ends, threaded one end, or continuous threaded.

2.5 Duct Hangers and Supports

.1 Conform to SMACNA manuals.

2.6 Flashing

.1 Steel Flashing: 0.5mm (26gauge) galvanized steel.

.2 Lead Flashing: 24.4kg/m² (5lb/ft) sheet lead for waterproofing, 4.88kg/m² (1 lb/ft^2) sheet lead for soundproofing.

.3 Safes: 24.4kg/m² (5lb/ft^2) sheet lead or 0.5mm (26gauge) neoprene.

.4 Caps: Steel, 0.8mm (22 gauge) minimum, 1.6mm (16 gauge) at fire resistance structures.

2.7 Sleeves

.1 Place pipe sleeves at all points where pipes pass through masonry or concrete walls or floors.

.2 Size sleeves in order to provide approximately 6.5mm (¼”) clearance, all around, between the sleeve and the duct or pipes, or where the pipe is insulated, provide approximately 6.5mm (¼”) clearance all around between the sleeve and insulation. Size sleeves through footings large enough to accommodate hub of cast iron soil pipe. Sleeve piping and drains where they pass below any footing to provide a minimum all around clearance of 50mm (2”) and backfill up the underside of the footing with concrete of the same strength as the footing.

.3 Terminate sleeves flush with walls and ceilings, 50mm above floors generally and 100mm above finished floor level in mechanical rooms.

.4 Where sleeves are required for pipes passing through the roof, anchor the sleeve in roof construction, caulk between sleeve recess and stack, fasten roof flashing to the clamp device, make a water-tight durable joint.

.5 Fill all voids between sleeve material and pipe, conduit or duct passing through. Use the following procedure for sleeve caulking:

.1 Where sleeves pass through walls or floors, caulk the space between the pipe and sleeve with dry oakum and seal each side with a non-hardening mastic.

.2 Ensure no contact between copper tube or pipe and ferrous sleeve.

.6 Where piping or ducts pass through a construction which is required to have a specific fire resistance rating, seal any space between the pipe or duct and the construction, including the space between the pipe or duct and the sleeve, with non-combustible insulating material and close off on both sides with tight fitting metal caps constructed of 1.6mm metal. Use caulking approved by the consultant and by all authorities having jurisdiction.

.7 Pipes through Floors: Form with steel pipe or approved PVC sleeves.

.8 Pipes through Beams, Walls, Fire Proofing, Footings, Potentially Wet Floor: Form with steel pipe.

.9 Ducts: Form with galvanized steel.

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

2.8 Seals

.1 Provide modular mechanical type seals between pipes and sleeves where passing through perimeter walls below grade (basement). These to consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve when linking bolts are tightened in sequence.

Standard of Acceptance: "Link-seal" by Thunderline.

2.9 Access Doors

.1 Types:

.1 Drywall Surface – Flanged Door: Universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.

.2 Drywall Surface – Hidden Flange: Access door with concealed bar hinge and rounded safety corners; flange of textured galvanized steel drywall taping bead with pre-punched holes; installed after drywall; Acudor DW-5040.

.3 Masonry: Universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.

.4 Tile Surface: Stainless steel, universal flush access door with concealed bar hinge and rounded safety corners; Acudor UF-5000.

.5 Plaster Walls and Ceilings: Access door with expansion casing bead and 75mm (3”) wide galvanized lath surround recessed 19mm (¾”) to receive plaster; Acudor PS-5030.

.6 Acoustic Plaster: 15mm (⅝”) 5ecessed access door with self-furring lath and 75mm (3”) galvanized lath surround recessed 19mm (¾”) to receive plaster; Acudor AP-5010.

.7 Acoustical Tile Ceilings: Door recessed 25mm (1”) to receive acoustic tile; Acudor AT-5020.

.8 Fire Rated Walls: Self-closing, self-latching door; ULC – 2 hour “B” label; For use when temperature rise is not a factor; Acudor FB-5060.

.9 Fire Rated Walls: Self-closing, self-latching door with 50mm (2”) fire rated insulation; ULC – 2 hour “B” label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; Acudor FW-5050.

.10 Fire Rated Ceilings: Self-closing, self-latching, inward opening door with 50mm (2”) fire rated insulation; ULC – 2 hour “B” label with a maximum temperature rise of 139°C (250°F) after 30 minutes; For use when temperature rise or heat transmission is a factor; Acudor FW-5050-UP.

.2 Construction

.1 Non-Rated Doors: One piece outer flange welded to mounting frame; Continuous, concealed hinge; Doors 400mm x 400mm (16”x16”) and smaller – 16 gauge door, 18 gauge mounting frame; Doors over 400mm x 400m (16”x16”) – 14 gauge door, 16 gauge mounting frame.

.2 Rated Doors: 25mm (1”) wide flange; Continuous, concealed hinge; 20 gauge door, 16 gauge mounting frame.

.3 Stainless steel screwdriver operate cam latch (non-rated doors); Universal self-latching bolt operated by a knurled knob or flush key (rated doors).

.4 Steel access doors: 5 stage iron phosphate preparation with prime coat of grey baked enamel.

.5 Stainless steel doors: #4 satin polish.

3. Execution

3.1 Inserts

.1 Use inserts for suspending hangers from 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 100mm (4”).

.3 For poured-in-place concrete, place inserts in a manner such that they are not disturbed during construction or interfere to the detriment of the strength of the structure.

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

.5 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed 100mm (4”) minimum square steel plate and nut above slab.

.6 Supply all templates, special frame inserts, etc., required to accommodate equipment supplied under this section and turn over to the contractor for installation. It is the responsibility of this section to ensure the correct placement and mounting of these items.

.7 All cutting and patching required to accommodate the installation of inserts is the responsibility of this section, but the appropriate trades are to do the work in a manner satisfactory to the architect.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size mm (in)	Distance Between Supports mm (in)		Hanger Rod Diameter mm (in)
	Steel	Copper	
15 (½”) to 20 (¾”)	1800 (72”)	1500 (60”)	10 (3/8”)
25 (1”) to 40 (1½”)	2100 (84”)	1800 (72”)	10 (3/8”)
50 (2”) to 65 (2½”)	3000 (120”)	2400 (96”)	10 (3/8”)
75 (3”) to 100 (4”)	3600 (144”)	3000 (120”)	15 (½”)
150 (6”) to 300 (12”)	4200 (168”)	4000 (160”)	20 (¾”)
350 (14”) to 450 (18”)	6000 (240”)	6000 (240”)	25 (1”)

.2 Install hangers to provide minimum 15mm (½”) clear space between finished covering and adjacent work.

.3 Use oversize hangers to accommodate pipe insulation thickness. For pipes up to 50mm (2”) use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65mm (2½”) and over use insulation protection saddle.

.4 Place a hanger within 300mm (12”) of each horizontal elbow.

.5 Use hangers which are vertically adjustable 40mm (1½”) minimum after piping is erected.

.6 On insulated copper piping, affix lead or other approved backing to ensure no contact between copper and ferrous hanger or other work.

.7 Support vertical piping not subject to expansion or contraction with bolted steel riser clamps at each floor level or a maximum of 3000mm (10’-0”), whichever is shorter. Secure vertical cast iron soil pipe with drive hooks at 1500mm (60”) intervals set below hubs, and by riser clamps at each floor level.

.8 Vertical piping subject to expansion or contraction where grooved joint couplers are used shall be supported with riser clamps at each floor level. Ensure at least one grooved joint occurs between each floor.

.9 Vertical piping subject to expansion or contraction where welded or threaded shall be supported and anchored at maximum 20mm intervals with expansion joints. Provide guides at each floor.

.10 Provide supports for chromium plated piping or tubing or either chromium plated cast brass or chromium plated die-cast zinc alloy. Where exposed, use chromium plated bolts, screws, and nuts for assembly and attachment of such supports. Use supports for pipes running along walls of such length that the clearance between the pipe and the face of the wall will not be less than 20mm and not more than 25mm.

.11 Place piping hung or supported by rising or clevis hangers directly onto the hanger and insulation carried over the hanger, finish insulation neatly where the hanger protrudes over the insulation. Provide piping 50mm and over with pipe covering protection saddles and insulation butted against the saddle, also provide insulation between the pipe and saddle.

.12 Where piping is supported from floor, use cast iron adjustable pipe saddle supports with locknut nipple, floor flange and concrete pier or steel support. Where provision for expansion or contraction is required, use adjustable pipe roll stands with vertical adjustment and concrete pier or steel support.

.13 Support cast iron horizontal drainage pipe near each hub and on each side of gasket and clamp joints, with 1500mm (60”) maximum spacing between hangers.

.14 For all horizontal drainage pipe (sanitary and storm) below structural slabs, provide clevis ring hangers supported from the structural slab.

.15 Provide insulation saddles for insulated pipe.

.16 For steel cold water insulated pipe, use prefabricated insulated shields with high density insulation and vapor barrier. Shield length to be four times insulation outside diameter.

.17 For all insulated copper piping, use shields of 1.2mm galvanized sheet metal, length two times insulation outside diameter and ½ the insulation circumference.

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

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

3.3 Duct Hangers and Supports

.1 Support duct work in accordance with SMACNA standards and, as a minimum, as follows.

3.4 Low Pressure Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750mm (30”) wide: 25mm (1”) x 1.6mm (16 gauge) at 3.0m (10 ft) spacing;

.2 775mm (31”) to 1200mm (48”) wide: 40mm (1½”) x 1.6mm (16 gauge) at 3.0m (10 ft) spacing;

.3 Over 1200mm (48”) wide: 40mm (1½”) x 1.6mm (16 gauge) at 3.4m (11ft) spacing.

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to450mm (18”) wide: 40mm (1½”) x 1.6mm (16 gauge) or 25mm (1”) x 3mm (12 gauge) at 3.4m (8ft) spacing;

.2 475mm (19”) to 1000mm (40”) wide: 40mm (1½”) x 40mm (1½”) x 3mm (12 gauge) at 1.2m (4ft) spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes:

.1 At 3.6mm (10 gauge) spacing:

.1 Up to600mm (24”) wide: 40mm (1½”) x 1.6mm (16 gauge);

.2 625mm (25”) to 900mm (36”) wide: 25mm (1”) x 25mm (1”) x3mm (12 gauge);

.3 925mm (37”) to 1200mm (48”) wide: 30mm (1¼”) x 30mm (1¼”) 3mm (12 gauge).

.4 Vertical Duct Floor Supports Minimum Sizes:

.1 Riveted or screwed to duct;

.1 Up to 1500mm (60”) wide: 40mm (1½”) x 40mm (1½”) x 3mm (12 gauge);

.2 Over 1500mm (60”) wide: 50mm (2”) x 50mm (2”) x 3mm (12 gauge).

3.5 Medium and High Pressure Duct Hangers and Supports

.1 Rectangular Duct Hangers Minimum Sizes:

.1 Up to 900mm (36”) wide: 2 at 25mm (1”) x 1.6mm (16 gauge) at 3.0m (10’-0”) spacing;

.2 925mm (37”) to 1500mm (60”) wide: 2 at 25mm (1”) x 1.6mm (16gauge) at 2.4m (8’-0”) spacing and 50mm (2”) x 50mm (2”) x 6mm (¼”) trapeze;

.3 1525mm (61”) to 3000mm (120”) wide: 2 at 40mm (1½”) x 2.7mm (12 gauge) at 2.4m (8’-0”) spacing and 50mm (2”) x 50mm (2”) x 6mm (¼”) trapeze;

.4 3200mm (128”) to 6000mm (240”) wide: 3 at 10mm (3/8”) diameter at 1.2m (4’-0”) spacing and 65mm (2½”) x 65mm (2½”) x 6mm (¼”) trapeze.

.2 Round Duct Hangers Minimum Sizes:

.1 At 3m (10’-0”) spacings:

.1 Up to 450mm (18”) diameter: 25mm (1”) x 1.6mm (16 gauge);

.2 475mm (19”) to 900mm (36”) diameter: 25mm (1”) x 2.7mm (12gauge);

.3 925mm (37”) to 1250mm (50”) diameter: 40mm (1½”) x 2.7mm (12 gauge);

.4 1300mm (51”) to 2000mm (80”) diameter: 2 at 40mm (1½”) x2.7mm (12gauge) from girth reinforcing angle.

.3 Vertical Duct Floor Supports Minimum Sizes:

.1 Up to 1200mm (48”) wide: 40mm (1½”) x 40mm (1½”) x 3mm (12 gauge);

.2 Over 1200mm (48”) wide: 50mm (2”) x 50mm (2”) x 5mm (3gauge).

.3 Rivet to duct and tie angles together with rod, angles or "band iron".

.4 Angle reinforcing may be used for support omitting trapeze.

3.6 Equipment Bases and Supports

.1 Provide reinforced concrete housekeeping bases poured directly on structural floor slab 100mm (4”) thick minimum, extended 100mm (4”) minimum beyond machinery bedplates for equipment. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Provide rigid anchors for ducts and pipes immediately after vibration isolation connections to equipment unless spring hangers are specified.

3.7 Flashing

.1 Flash and counter-flash where mechanical equipment passes through weather or waterproofed walls, floors and roofs.

.2 Provide curbs for mechanical roof installations 300mm (12”) minimum high. Flash and counter-flash with galvanized steel, soldered and make waterproof. Coordinate with roofing contractor.

.3 Provide lead acoustic flashing around duct and pipes passing from equipment rooms, installed according to manufacturer's data for sound control.

.4 Flash vent and soil pipes projecting 75mm (3”) minimum above finished roof surface with lead worked 25mm (1”) minimum into hub, 200mm (8”) minimum clear on sides with minimum 600mm x 600mm (24”x24”) sheet size. For pipes through outside walls, turn flange back into wall and caulk.

.5 Flash floor drains over finished areas with lead 250mm (10”) clear on sides with minimum 900mm x 900mm (36”x36”) sheet size. Fasten flashing to drain clamp device.

.6 Provide continuous lead or neoprene safes below built-up mop sinks, shower stalls, and shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150mm (6”) into walls or to top of curbs and caulk into joints.

3.8 Sleeves

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

.2 Extend sleeves through potentially wet floors 25mm (1”) above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and duct work passing through floor, ceiling or wall, close off space between duct and sleeve with non-combustible insulation. Caulk both sides.

.4 Piping passing through perimeter walls below grade, meter room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25mm (1”) 'flange' welded to the external face of the sleeve at the mid-point of the thickness of the structure to provide a water stop.

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

3.9 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Valves

.2 Volume and splitter dampers

.3 Fire Dampers

.4 Expansion joints

.5 Control components

.6 Cleanouts and traps

.2 Where access is required through removable acoustic tile ceilings, identify with colored round stickers (6mm diameter) on all tees adjacent the tiles to be used for access.

.3 Where equipment is concealed by a continuous structural or architectural surface, supply access doors of design to suit and match the surface in which they will be installed.

.4 Provide stainless steel doors in walls of washrooms, janitor rooms and laundry rooms.

.5 When located in a finished floor with tile, stonework, terrazzo, etc., a recessed bearing type access door is required. The door surface shall have a recess to take the particular surface and pattern if this is available at the time the units are ordered.

.6 Provide ULC listed fire rated access doors when installed in fire rated walls and ceilings.

.7 300mm x 300mm (12”x12”) minimum, for inspection and hand access.

.8 450mm x 450mm (18”x18”) minimum, larger if indicated on drawings, where entry is required and access is difficult.

.9 Size access door to suit masonry modules when located in a masonry wall.

.10 Refer to architectural reflected ceiling plan for size and location of additional access doors.

.11 Ensure the number of access doors required is maintained at a minimum by locating mechanical components requiring access in accessible locations such as removable tile ceilings, etc.

.12 Provide a schedule of access doors showing location, type and size, together with samples, to the consultant for approval before installation. Avoid locating access doors in feature walls or ceilings without prior approval of the consultant.

.13 Access doors will be provided under Section 23 05 29, but installed by the trade governing the surface in which they are to be installed.

3.10 Metal Supports

.1 Except where detailed on structural drawings, design, construct and install metal supports, stands, platforms and other metal structures including maintenance platforms required for and associated with the mechanical equipment. Ensure that structures are designed so that loads and impact loads are properly distributed into building structure.

.2 Where equipment is indicated or specified to be floor mounted on stands or legs, fabricate these from structural steel section and/or steel pipe with adequate bracing and steel plate flanges for bolting to the concrete base or floor.

.3 Where ceiling or wall mounting is indicated or specified, use a suspended platform, bracket or shelf, whichever is most suitable for the equipment and its location. Fabricate from standard structural steel sections and plate and/or steel pipe. Ensure that these structures are adequately fastened to the building structure.

.4 Supports must be large enough to support the equipment along the entire length and width. Adequate provision must be made to install isolators if necessary either below the support or between support and the equipment.

.5 If necessary to provide continuous and rigid support for equipment components, mount all components on channel or '‘I” beams before mounting on isolators.

.6 Vertical tanks are to be supported by adjustable jack legs and horizontal tanks by saddles with correct curvature for tank shell.

END OF SECTION

1. General

1.1 Scope

.1 Vibration isolation for piping, ductwork and equipment

.2 Equipment isolation bases

.3 Flexible piping connections

.4 Resilient pipe anchors and guides

1.2 General

.1 Supply all labor, materials, and equipment required and necessary to isolate and restrain the equipment as indicated on the drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Obtain all relevant equipment information and provide shop and placement drawings for all vibration isolation elements for review, before materials are ordered. The drawings shall bear the stamp and signature of the responsible supplier's technical representative.

.3 Provide attachment to both the equipment and the structure meeting the specified forces involved.

1.3 Quality Assurance

.1 Provide and install appropriate vibration isolation materials/products on mechanical equipment so that Average Noise Criteria curves, as outlined in ASHRAE Guide, are not exceeded.

.2 All elastomeric components in type 1, type 2 isolation mounts shall be bridge bearing neoprene, meeting CSA Standard CAN3-S6 Section 11.10.

.3 All vibration isolators and bases shall be supplied by an approved supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.4 The work shall be carried out in accordance with the specification and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.5 Equipment supplier to ensure equipment is sufficiently rigid for isolator point loading. Project Mechanical Consultant must be advised of any equipment which requires an additional support base, at least 7 working days prior to tender closing.

1.4 Submittals

.1 The manufacturer of vibration isolation shall provide submittals for products as follows:

.1 Descriptive Data:

.1 Schedule of flexibly mounted equipment, referencing drawings by number.

.2 Catalog cut or data sheets on vibration isolators.

.2 Drawings:

.1 Submit details of equipment bases including dimensions, structural member sizes and support point locations.

.2 Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.

.3 Submit details of mountings for floor supported equipment, piping and ductwork.

.4 All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.

.5 Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.

.6 Complete flexible connecter details.

.2 Provide an equipment isolation schedule that provides design data for each isolator including: spring O.D., free operating and solid heights, minimum static deflection, and ratio of horizontal to vertical stiffness.

1.5 Description

.1 Provide vibration isolation on all motor driven equipment with motors of 0.37 kW (0.5 HP) and greater power output (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than 0.37 kW (0.5 HP), provide neoprene grommets at the support points.

.2 Electrical cable connected to isolated equipment shall allow for a minimum ±25mm (±1”) of equipment movement in any direction.

.3 Ensure isolation systems have a vertical natural frequency no higher than one third of the lowest forcing frequency, unless otherwise specified. Use dynamic stiffness in selection of elastomers and do not exceed 60 durometer.

.4 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.5 Isolators and restraining devices which are factory supplied with equipment shall meet the requirements of this section.

.6 Provide concrete inertia bases where specified or required by equipment manufacturer located between all vibrating equipment and the vibration isolation elements. Provide inertia bases on base mounted pumps over 7.5 kW (10 HP), except slab on grade installations. Refer to structural specifications for concrete work. Concrete work by General Contractor.

.7 Co-ordinate with Division 3 for the provision of housekeeping pads at least 100mm (4”) high under all isolated equipment and where indicated on drawings. Provide at least 175mm (7”) clearance between drilled inserts and edge of housekeeping pads and follow structural consultant's instructions for drilled inserts.

.8 Bolt all equipment to the structure. Do not bridge isolation elements.

1.6 Inspection

.1 The contractor shall notify the local representative of the vibration isolation materials manufacturer prior to installing any vibration isolation devices. The contractor shall seek the representative’s guidance in any installation procedures with which he is unfamiliar.

.2 A qualified representative of the isolator manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.

.3 On completion of installation of all noise and vibration isolation devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation devices, or other fault in the system that could affect the performance of the system.

.4 The installing contractor shall submit a report to the Engineer, including the manufacturer representatives’ final report, indicating all isolation material is properly installed or steps to be taken by the contractor to properly complete the isolation work as per specification.

2. Products

2.1 Acceptable Manufacturers

1. Vibration Controls: Kinetics, IAC Acoustics, Korfund, Mason, Vibro-Acoustic

2.2 Isolators

.1 All isolators shall be of the following types, supplied by approved manufacturers.

.2 Vibration isolators shall have minimum operating static deflections as indicated in the Vibration Isolation Schedule or as indicated on the project documents but not exceeding published load capacities.

.3 Isolation hangers shall be selected by the manufacturer for each specific application to comply with deflection requirements as shown on the Vibration Isolation Schedule or as indicated on the project documents.

.4 Springs shall be selected to provide operating static deflections shown on the Vibration Isolation Schedule or as otherwise indicated on the project documents. Springs shall be color coded or otherwise identified to indicate load capacity.

.1 Type 1 – Fiberglass Pad Isolator (Floor Mounted Equipment)

Isolator pads shall be pre-compressed molded fiberglass pads individually coated with a flexible, moisture impervious elastomeric membrane. Vibration isolation pads shall be molded from glass fibers with fiber diameters not exceeding 6.8 microns (0.00027in) and with a modulus of elasticity of 738,223 kg/cm² (10.5 million psi). Natural frequency of fiberglass vibration isolators shall be essentially constant for the operating load range of the supported equipment. Isolators shall be color coded or otherwise identified to indicate the load capacity.

Vibration isolators shall be as described above bonded to a steel load transfer plate and a formed steel bolt-down bracket, and shall also include an equipment mounting bolt with anti-short circuit neoprene grommet.

.2 Type 1 – Rubber Pad Isolators

Isolation pads shall be neoprene elastomer in-shear pads, used in conjunction with steel shims where required, having static deflections as tabulated. All pads shall be elastomer in-shear and shall be molded using 17,237 kPa (2500 psi) minimum tensile strength, oil resistant neoprene compounds with no color additives. Pads shall be 50 durometer and designed to permit 413.7 kPa (60 psi) loading at a maximum rated deflection of 4mm (0.15"). When two isolation pads are laminated, they shall be separated by, and bonded to, a galvanized steel shim plate.

Neoprene vibration isolators shall have minimum operating static deflections as shown on the Vibration Isolation Schedule, or as indicated on the project documents, but not exceeding published load capabilities.

.3 Type 2 – Rubber Mounts (Floor Mounted Equipment)

Isolator pad to be neoprene, molded from oil-resistant compounds with cast-in-top steel load transfer plate for bolting to supported equipment, and a bolt-down plate with holes provided for anchoring to supporting structure. Top and bottom surfaces shall have non-skid ribs.

.4 Type 2 – Rubber Hanger (Suspended Equipment)

Vibration isolators with maximum static deflection requirements under the operating load conditions not exceeding 10.2mm (0.40”) shall be hangers consisting of an elastomer-in-shear insert encased in a welded steel bracket and provided with a stamped load transfer cap. The elastomer insert shall be neoprene, molded from oil resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The hanger shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or short circuit.

.5 Type 3- Spring Isolators (Floor Mounted Equipment)

Vibration isolators shall be free standing, unhoused, laterally stabile steel springs. Springs shall have a lateral stiffness greater than 1.0 times the rated vertical stiffness and shall be designed to provide a minimum 50% overload capacity. Springs shall be assembled or welded between top and bottom load plates. The upper load plate shall be provided with steel leveling bolts, lock nut and washer for attachment to the supported equipment. The lower load plate shall incorporate a non-skid noise isolation pad and shall have provisions for bolting the isolator to the supporting structure, as required.

.6 Type 3 – Spring Isolators (Suspended Equipment, Piping & Ductwork)

Vibration isolators for suspended equipment, with minimum static deflection requirement exceeding 10mm (0.4"), shall be hangers consisting of a free-standing, laterally stabile steel spring and elastomeric washer in series, assembled in a stamped or welded steel bracket. The bracket shall be finished with a polyester powder coating. The manufacturer shall provide independent laboratory testing showing that the bracket with this finish has endured a minimum of 1,000 hours of exposure to salt spray fog testing per ASTM B117 without signs of corrosion. The hanger bracket shall be designed to carry a 500% overload without failure and to allow a support rod misalignment through a 30-degree arc without metal-to-metal contact or other short circuit. Springs shall have a minimum lateral stiffness of 1.0 times the rated vertical stiffness.

Vibration isolators for suspended equipment with minimum static deflection requirement exceeding 10mm (0.4"), and where both high and low frequency vibration is to be isolated, shall be hangers consisting of a laterally stable steel spring in series with a pre-compressed molded fiberglass insert, complete with a load plate and assembled in a stamped or welded steel bracket. The fiberglass insert shall be individually coated with a flexible, moisture-impervious elastomeric membrane. The insert shall be molded from glass fibers with fiber diameters not exceeding 6.8 microns (.00027") and with a modulus of elasticity of
738,223 kg/cm² (10.5 million psi). Natural frequency of fiberglass vibration isolators shall be essentially constant for the operating load range of the

supported equipment. The bracket shall meet the requirements noted above. The spring element shall meet the requirements noted above.

Vibration isolators for suspended equipment with minimum static deflection requirement exceeding 0.4" (10 mm), and where both high and low frequency vibrations are to be isolated, shall be hangers consisting of a laterally stable spring in series with an elastomer-in-shear insert complete with load transfer plates and assembled in a stamped or welded steel bracket. The elastomer insert shall be molded from oil-resistant compounds and shall be color coded to indicate load capacity and selected to operate within its published load range. The bracket shall meet the requirements noted above. The spring element shall meet the requirements noted above.

.7 Type 4 – Spring Isolators (Floor Mounted Variable Weight Equipment)

Vibration isolators for equipment which is subject to load variations and large external or torquing forces (such as chillers and cooling towers) shall consist of large diameter laterally stabile steel springs assembled into welded steel housing assemblies designed to limit vertical movement of the supported equipment. Housing assemblies shall be fabricated steel members and shall consist of a top load plate complete with adjusting and leveling bolts, vertical restraints, isolation washers and a bottom plate with internal non-skid noise isolation pads. Housing shall be electrozinc plated or hot dip galvanized for corrosion resistance. Housing should be designed to provide a constant free and operating height within 0.06mm (1/8"). Spring elements shall have a lateral stiffness greater than 1.2 times the rated vertical stiffness and shall be designed to provide a minimum of 50% overload capacity. Non-welded spring elements shall be polyester powder coated, and shall have a 1000 hr rating when tested in accordance with ASTM B-117.

2.3 Bases

.1 All bases shall be of the following types, supplied by approved manufacturers.

.1 Type A – Direct Isolation

No base required. Isolators may be attached directly to the supported equipment.

.2 Type B – Structural Bases

Bases shall be fabricated from structural beam sections with welded isolator brackets and pre-located anchor bolt holes, and shall be designed and supplied by the isolation materials manufacturer. Section depth of each member shall be greater than 10% of the longest span between supporting isolators, or as shown on the drawings or indicated in the project documents. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment. Lateral cross members shall be added to form a structurally integral, welded frame to provide a rigid, distortion-free frame to support and anchor separate equipment components or driving and driven members.

.3 Type B – Structural Rails

Bases shall be structural beam sections, with welded on isolator support brackets and pre-located and drilled anchor bolt holes or skids, and shall be designed and supplied by the isolation materials manufacturer. Beam sections shall not be structurally connected to each other. Minimum section depth of each member shall be equal to 8% of the longest span between supporting isolators, or as shown on the drawings or indicated on the project documents. Isolator support brackets shall be welded to the structural beams as required to obtain the lowest mounting height for the supported equipment.

.4 Type C – Concrete Bases

Bases shall be constructed of concrete cast into a prefabricated inertia base frame assembly designed and supplied by the isolation materials manufacturer. Frame members shall be welded to form a structurally integral assembly, complete with primer-painted steel perimeter members, welded and tied reinforcing rods, recessed isolator brackets and equipment anchoring bolts. Bases shall be shipped ready for pouring of concrete fill in the field.

.5 Type D – Curb Isolation

Rails to support rooftop equipment shall be designed to provide isolation against the transmission of vibrations to the building structure. Rail assembly shall consist of extruded or roll-formed top and bottom members with spring isolators incorporated and with a continuous air and water seal provided for the entire rail perimeter. Spring isolators shall be selected and spaced according to weight distribution. Spring components shall meet all the specified characteristics as described in Type 3 – Spring Isolators (Floor Mounted Equipment).

2.4 Acoustical Split Wall Seals

.1 Acoustical walls seals shall be used where indicated on drawings.

.2 Split seals shall consist of pipe halves with minimum 20mm (3/4") thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not in place prior to the construction of the building member. Seals shall project a minimum of 25mm (1") past either face of the wall. Where temperatures exceed 115°C (240°F), 10 lb. density fiberglass may be used in lieu of the sponge.

2.5 Pipe Riser Anchors

.1 Risers shall be restrained against excessive movement during service by the use of 3-axis resilient anchors designed to withstand the required installation and operating forces.

Anchors are intended to be used in sets of two (2), and be oriented to effectively restrain the riser in all three directions, with particular emphasis on large and variable vertical loads that would be imparted by changes in the riser weight.

.2 Anchors shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design loads. Snubbers shall limit lateral and vertical riser movement at each anchor location to a maximum of 6mm (¼”) in any direction. Anchors shall include a minimum 13mm (½”) thick resilient 60 durometer neoprene pad to cushion any impact and to avoid any potential for metal-to-metal contact. Maximum neoprene bearing pressure shall not exceed 10.4 N/mm^2 (1500 psi). Anchors shall be capable of withstanding an externally applied force of up to their rated capacity in any direction.

2.6 Pipe Riser Guides

.1 Risers shall be restrained against excessive lateral movement during service by the use of 2-axis resilient guides designed to withstand the required installation and operating forces. Guides are intended to be used in sets of two (2), and be oriented to effectively restrain the riser in all horizontal directions, but to allow free motion within their operating range in the vertical axis.

.2 Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 13mm (½”) thickness of 60 durometer or softer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Guides shall be capable of ±40mm (±1⅝”) motion, or to meet location requirements.

.3 Select isolators at the supplier's optimum recommended loading, and do not load beyond the limit specified in the manufacturer's literature.

.4 Design springs in accordance with the Society of Automotive Engineers' Handbook Supplement 9 entitled "Manual on Design and Application of Helical and Spiral Springs - SAE - 1975".

.5 Design springs "iso-stiff" (kx/ky = 0.8 to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.

.6 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for all isolation equipment located out of doors or in areas where moisture may cause corrosion.

2.7 Flexible Pipe Connectors

.1 Braided spools for steel piping up to 50mm (2” diameter): Stainless steel inner core and braid welded; schedule 40 carbon steel NPT nipples; suitable for service at 1724 kPa (250 psi) at 120°C (250°F).

Standard of Acceptance: Flexonics BSN connector

.2 Braided spools for copper piping: Bronze hose and braid; copper female sweat ends; suitable for 1035 kPa (150 psi) at 21°C (70°F).

Standard of Acceptance: Flexonics BRC connector

Male Nipples (Min. Lengths)

15x300mm (½”x12”)	30x300mm (1¼”x12”)	50x300mm (2”x12”)
20x300mm (¾”x12”)	40x300mm (1½”x12”)	65x450mm (2½”x18”)
25x300mm (1”x12”)		

.3 Braided spools for steel piping 65mm (2½”) and over: Stainless steel inner core and braid; 150lb raised face forged steel slip on flanges; suitable for service at 951 kPa (138 psi) at 120°C (250°F).

Standard of Acceptance: Flexonics BSFS connector

Flanged (Min. Lengths)

75x300mm (3”x12”)	150x450mm (6”x18”)	300x600mm (12”x24”)
100X300mm (4”x12”)	200x450mm (8”x18”)	350x750mm (14”x30”)
125x450mm (5”x18”)	250x450mm (10”x18”)	400x800mm (16”x32”)

2.8 Flexible Rubber Connectors

.1 Rubber expansion joints shall be peroxide cured EPDM throughout with Kevlar tire cord reinforcement. Substitutions must have certifiable equal or superior characteristics. The raised face rubber flanges must encase solid steel rings to prevent pull out. Flexible cable wire is not acceptable. Sizes 40mm to 350mm (1½" to 14") shall have a ductile iron external ring between the two spheres. Sizes 400mm to 600mm (16" to 24") may be single sphere. Sizes 20mm to 50mm (¾" to 2") may have one sphere, bolted threaded flange assemblies and cable retention.

.2 Minimum ratings through 350mm (14") shall be 1724 kPa at 77°C and 1482 kPa at 121°C (250psi at 170°F and 215psi at 250°F). 400mm to 600mm (16"to 24") shall be 1241 kPa at 77°C and 1034 kPa at 121°C (180psi at 170°F and 150psi at 250°F). Higher published rated connectors may be used where required.

.3 Safety factors shall be a minimum of 3/1. All expansion joints must be factory tested to 150% of maximum pressure for 12 minutes before shipment.

.4 The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 13mm (½”) thick neoprene washer bushings large enough to take the thrust at 0.7 kg/mm2 (1000psi) of surface area may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.

.5 All expansion joints shall be installed on the equipment side of the shut off valves.

2.9 Flexible Pump Connections

.1 Install flexible connections for all centrifugal floor mounted pumps and in line pumps in such a manner that vibrations and transmission thereof are eliminated. Flexible connectors shall be twin sphere, peroxide cured EPDM, Kevlar reinforced, solid steel rings with raised face rubber flanged ends, ductile iron external ring between spheres.

3. Execution

3.1 Application

.1 Execute the work in accordance with the specifications and, where applicable, in accordance with the manufacturer's instructions and only by workmen experienced in this type of work.

.2 For all equipment mounted on vibration isolators, provide a minimum clearance of 50 mm to other structures, piping, equipment, etc.

.3 Use the lowest RPM scheduled for two speed equipment in determining isolator deflection.

.4 Installation of vibration isolators must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

.5 No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

.6 The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. “Building” includes, but is not limited to, slabs, beams, columns, studs and walls.

.7 Coordinate work with other trades to avoid rigid contact with the building.

.8 Any contacts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the engineer’s attention prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor’s expense.

.9 Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor’s expense.

.10 Where piping connected to noise generating equipment is routed from the mechanical room through plumbing chases, position piping to avoid contact with the concrete structure, future framing, drywall and other finishes which may radiate noise. Provide an acoustical barrier such as fibrous material and resilient acoustical caulking or acoustical split wall seals. Refer to drawings for acoustic barrier locations and requirements. Submit proposed details to meet this requirement.

.11 Locate isolation hangers as near to the overhead support structure as possible.

.12 Isolator hangers shall be installed with the housing a minimum of 6mm (¼”) below but as close to the structure as possible. Where isolator hangers would be concealed by non-accessible acoustical sub-ceiling, install the hangers immediately below the sub-ceiling for access.

.13 Provide spring thrust restraints on all fans (except vertical discharge) in excess of 1 kPa (0.15 psi) static pressure, and on hanger supported, horizontally mounted axial fans with more than 333 N thrust due to static pressure.

.14 Horizontal limit springs shall be provided on fans operating in excess of 1.5 kPa (6” WG) static pressure, except vertical discharge fans, and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N.

.15 Provide spring-loaded thrust restraints for fans and air handling units where movement under any operating condition will exceed 10mm (0.375”).

.16 Before bolting isolators to the structure, start equipment and balance the systems so that the isolators can be adjusted to the correct operating position before installing anchors.

.17 When recommended by the manufacturer, isolator base plates shall be bolted to the structure or foundation. Bolting shall incorporate neoprene bushings and washers.

.18 Where hold down bolts for isolators penetrate roofing membranes, provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene.

.19 Flexible pipe connectors per 2.5.1 shall be provided and installed per Table 3.0T1. Where not required, Contractor shall make provision for possible future installation by installing appropriate spool pieces.

.20 Where a pump intake pipe or similar pipe configuration requires a pedestal support, construct inertia or steel base large enough to accommodate pedestal.

.21 Provide vibration isolation for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.22 Set steel bases for 25mm (1”) clearance between housekeeping pad and base. Set concrete inertia bases for 50mm (2”) clearance. Adjust equipment level.

.23 Deflections 12mm (½”) and over shall use steel spring isolators.

.24 Deflections 5mm (¼”) and under shall use neoprene isolators.

.25 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm (2”) to other structures, piping, equipment, etc. All isolators shall be adjusted to make equipment level.

.26 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.27 Adjustable, horizontal stabilizers on close spring isolators shall be adjusted so that the side stabilizers are clear under normal operating conditions.

.28 Isolation hangers, as outlined in table 3.0T1, shall be provided on all piping in mechanical and boiler rooms for a minimum of the first three (3) support points for piping up to 100mm diameter, first four (4) support points for piping 125mm to 200mm diameter and for the first six (6) points on piping 250mm diameter and above.

.29 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector:

Pipe Size	Distance, m (ft)
15 - 40mm (½” - 1½”)	3.0 (10’-0”)
50 - 65mm (2” - 2½”)	4.5 (15’-0”)
75 - 100mm (3” - 4”)	7.0 (23’-0”)
125 - 200mm (5” - 8”)	9.0 (30’-0”)
225 - 275mm (9” - 11”)	13.5 (44’-0”)
300 - 350mm (12” - 14”)	15.0 (50’-0”)

The three closest hangers to the vibration source shall be selected for the lesser of a 25mm (1”) static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25mm (2”) static deflection or 1/2 the static deflection of the isolated equipment.

Pipe Size	Distance from Vibrating Equipment
50 to 100mm (2” to 4”)	15m (50’)
150 to 200mm (6” to 8”)	18m (60’)
250mm & Larger (10” & Larger)	21m (70’)

.30 Domestic Cold and Hot Water Piping:

.1 Horizontal:

.1 Pipe stand supports shall be supported on Type 4 isolators. The first three (3) isolators shall have the same minimum static deflection as the equipment isolators. The remaining isolators shall have a minimum 25mm (1”) static deflection.

.2 Piping shall be suspended with Type 3 (spring & neoprene) isolators. The first three (3) hangers shall have the same maximum static deflection as the equipment isolators, with a maximum of 50mm (2”). The remaining isolators shall have a minimum of 25mm (1”) static deflection.

.2 Vertical:

.1 Piping shall be isolated from the supporting members or structure with Type 3 (Floor mounted equipment) isolators with a minimum 25mm (1”) static deflection.

.3 Piping attached to either coil sections separated from fan sections of air handling units by flexible connections, or to air handling units with internal vibration isolators meeting the requirements of these specifications is exempt from these requirements.

.31 Extent of ductwork isolations:

.1 Provide isolation for ductwork as indicated on the drawings.

.1 Suspended ductwork shall be supported by Type 3 isolators with a minimum 25mm (1”) static deflection.

.2 Floor supported ductwork shall be isolated from the structure with Type 3 (Floor mounted equipment)

.32 Specified supplemental equipment base types can be deleted for unitary packaged air handling equipment having a rigid frame and casing providing a distortion free platform for attachment of vibration isolators.

.33 Noise and vibration isolator types and minimum operating static deflections for suspended, or floor mounted, sheet metal ductwork air plenums, pressure reducing valves, sound traps and similar air distribution elements shall be as follows:

.1 Type 2 hangers, or Type 2 floor mounts, with minimum operating static deflections equal to 50% of connected equipment isolator deflection, or 25mm (1”), whichever is greater, shall be used to support all sheet metal air distribution elements located within mechanical equipment rooms, traveling between equipment rooms, and for a minimum of 15m (50’) from connections to vibration isolation mechanical equipment.

.2 Type 2 hangers, or floor mounts, with minimum operating static deflection of 25mm (1”), shall be used to support all sheet metal ductwork having air velocities of 5.08 m/s (1000 fpm) and higher, which is supported by structures above or below spaces having noise criteria levels of NC 35 or lower.

.34 On completion of installation of all insolation materials and before startup of isolated equipment all debris shall be cleared from areas surrounding and from beneath all isolated equipment leaving equipment free to move on the isolation supports.

.35 Spring hangers shall be installed without binding.

.36 Adjust isolators as required and ensure springs are not compressed.

.37 Provide neoprene side snubbers or retaining springs where side torque or thrust may develop.

.38 Where movement limiting restraints are provided, they shall be set in a position with minimum 6mm (¼”) air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3g (0.006615 lb) without permanent distortion or damage.

.39 Wiring connections to isolated equipment shall be flexible.

3.2 Performance

.1 Install inertia bases of type and thickness as indicated on Isolation Schedule.

.2 Install isolators of type and deflection as indicated on the Isolation Schedule or according to the following table, whichever provides the greater deflection.

Vibration Isolation Schedule
(from 2007 ASHRAE Handbook)

			Equipment Location											
						Floor Span								
			Slab on Grade			Up to 6.1m (20 ft)			6.1 to 9.1m (20 to 30 ft)			9.1 to 12.2m (30 to 40ft)		
Equipment Type	kW (HP) & Others	RPM	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)	Base Type	Isolator Type	Min. Defl. mm (in)
Pumps														
Close-Coupled	≤5.59 (≤7.5)	All	B	2	6 (0.25)	C	3	19 (0.75)	C	3	19 (0.75)	C	3	19 (0.75)
	≥7.46 (≥10)	All	C	3	19 (0.75)	C	3	19 (0.75)	C	3	38 (1.50)	C	3	38 (1.50)
Cabinet Fans, Fan Sections														
≤ 550Ø (≤ 22”Ø)	All	All	A	2	6 (0.25)	A	3	19 (0.75)	A	3	19 (0.75)	C	3	19 (0.75)
Centrifugal Fans														
≤ 550Ø (≤ 22”Ø)	All	All	B	2	6 (0.25)	B	3	19 (0.75)	B	3	19 (0.75)	C	3	38 (1.50)
≥ 600Ø (≥ 24”Ø)	≤29.8 (≤40)	Up to 300	B	3	64 (2.50)	B	3	89 (3.50)	B	3	89 (3.50)	B	3	89 (3.50)
		300 to 500	B	3	38 (1.50)	B	3	38 (1.50)	B	3	64 (2.50)	B	3	64 (2.50)
		501 & Up	B	3	19 (0.75)	B	3	19 (0.75)	B	3	19 (0.75)	B	3	38 (1.50)
	≥37.3 (≥50)	Up to 300	C	3	64 (2.50)	C	3	89 (3.50)	C	3	89 (3.50)	C	3	89 (3.50)
		300 to 500	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)	C	3	64 (2.50)

		501 & Up	C	3	25 (1.00)	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)
Condensing Units	All	All	A	1	6 (0.25)	A	4	19 (0.75)	A	4	38 (1.50)	A/D	4	38 (1.50)
Package AH, AC, H and V Units														
All	7.46 (10)	All	A	3	19 (0.75)	A	3	19 (0.75)	A	3	19 (0.75)	A	3	19 (0.75)
	≥15 (≤11.2), < 1.00 kPa (< 4”) SP	Up to 300	A	3	19 (0.75)	A	3	89 (3.50)	A	3	89 (3.50)	C	3	89 (3.50)
		301 to 500	A	3	19 (0.75)	A	3	64 (2.50)	A	3	64 (2.50)	A	3	64 (2.50)
		501 & Up	A	3	19 (0.75)	A	3	38 (1.50)	A	3	38 (1.50)	A	3	38 (1.50)
	≥15 (≤11.2), ≥ 1.00 kPa (≥ 4”) SP	Up to 300	B	3	19 (0.75)	C	3	89 (3.50)	C	3	89 (3.50)	C	3	89 (3.50)
		301 to 500	B	3	19 (0.75)	C	3	38 (1.50)	C	3	64 (2.50)	C	3	64 (2.50)
		501 & Up	B	3	19 (0.75)	C	3	38 (1.50)	C	3	38 (1.50)	C	3	64 (2.50)
Packaged Rooftop Equipment	All	All	A/D	1	6 (0.25)	D	3	19 (0.75)						
Ducted Rotating Equipment														
Small fans, fan-powered boxes	≤ 283 L/s (≤ 600 CFM)	All	A	3	13 (0.50)	A	3	13 (0.50)	A	3	13 (0.50)	A	3	13 (0.50)
	≥ 284 L/s (≥ 601 CFM)	All	A	3	19 (0.75)	A	3	19 (0.75)	A	3	19 (0.75)	A	3	19 (0.75)

END OF SECTION

1. General

1.1 Scope

.1 Painting and identification of equipment, piping and related components for the following:

.1 Fire Protection Systems

.2 Plumbing Systems

.3 Ventilation Systems

.4 Refrigeration Systems

1.2 Reference Standards

.1 Canadian General Standards Board (CGSB)

.1 CGSB-1-GP-12c; Color Identification and Selection

.2 CAN/CGSB-24.3 – Identification of Piping Systems

.2 Canadian Gas Association (CGA)

.1 CAN/CGA B149.1-15, Natural Gas and Propane Installation Code

.3 National Fire Protection Association (NFPA)

.1 NFPA 13-2010, Standard for the Installation of Sprinkler Systems

.4 American Society of Mechanical Engineers (ASME)

.1 ASME A13.1-2007, Scheme for the Identification of Piping Systems

.5 Federal Standard 595C – Colors

.6 WHMIS Pictograms – Workplace Hazardous Materials Information System – GHS Globally Harmonized System of Classification and Labeling Chemicals) – Pictograms

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Related Work Specified in Other Sections

.1	Submittal Procedures	Section 01 33 00
.2	Interior Painting	Section 09 91 23
.3	Common Work Results for HVAC	Section 23 05 00

1.6 Quality Control

.1 Coordinate color coding of piping and equipment with work of Section 09 90 00.

.2 All painting identified in this section is to be performed by Section 09 91 00 – Painting Contractor, under the direction of the Division 23 contractor.

.3 Color code mechanical equipment, piping and exposed ductwork. Refer to Part 3 of this section.

.4 Submit a schedule of pipe and equipment identification methods, materials and colors to the Engineer for review.

1.7 Definitions

.1 For the purposes of this Section, the following definitions apply:

.2 Concealed: Piping, ductwork and equipment in trenches, shafts, furrings and suspended ceilings.

.3 Exposed: Piping, ductwork and equipment in mechanical rooms or otherwise not “concealed”.

1.8 Equipment Protection and Cleanup

.1 Ensure that new and existing equipment and surfaces are carefully covered with tarping, or heavy duty plastic. Ensure that spills and splatter on finishes and equipment are cleaned up totally and promptly.

2. Products

Not Applicable

3. Execution

3.1 Identification Labels

.1 Identification Labels for all mechanical piping and ductwork systems, to include:

.1 WHMIS Pictogram (as applicable), same color as legend letters.

.2 A lettered legend on a coloured background, defining the contents in the pipe, its pressure and temperature and the information necessary to define the hazard.

.3 Arrows to define the direction of flow, same colour as legend letters.

.4 50mm (2”) wide black tape at each end of the label, wrapped around the entire circumference of pipe/insulation to secure the Identification Labels.

.2 Identification Labels may be accomplished by paint, stenciling and/or factory fabricated labels. Labels shall cover full circumference of pipe or insulation.

3.2 Location of Labels

.1 Orient labels on piping systems in visual sight lines while standing at floor levels.

.2 Locate labels as follows:

.1 Upstream of valves.

.2 Adjacent to changes in direction.

.3 Branches.

.4 Where pipes pass through walls or floors.

.5 On straight pipe runs at 6 m intervals.

.6 Where system is installed in pipe chases, ceiling spaces, shafts, or similar 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.

.3 Adhere labels to piping/insulation. Labels to cover entire pipe circumference. Secure both ends of labels with 50mm (2”) wide black tape around the entire pipe circumference.

3.3 Ductwork Identification

.1 Use 65mm high black stenciled letters with arrows indicating flow. Identify both systems number and type of air where possible.

.1 Duct identification to be:

Duct Service	**Legend**
Supply Air, Air Handling Unit # [ ]	S/A – AH-[ ]
Return Air, Air Handling Unit # [ ]	R/A – AH-[ ]
Outside Air Intake, Air Handling Unit # [ ]	O/A – AH-[ ]
Exhaust or Relief Air, Air Handling Unit # [ ]	E/A – AH-[ ]
Exhaust Air, Exhaust Fan # [ ]	E/A – EF-[ ]

.2 Maximum distance between markings to be no more than 15 meters maximum. Identify duct on each side of dividing walls or partitions and behind each access door.

.3 Division 23 Contractor to apply stencil lettering only after the final finish has been applied.

3.4 Piping Identification

.1 Identification Methods

.1 Piping identification system entails primary color, or pipe marker, secondary color strip, pipe service legend and direction of flow arrow

.2 Primary color, where required, shall be applied to pipe in its entirety.

.3 Secondary color strips minimum of 600mm (24”) long shall be applied at 6 meter (20 ft) intervals, at change of direction, at both sides of walls and floors where penetrated, at each piping rise or drop, at major branch connections and major valves, at service connections to equipment, and at least ones in each room through which piping passes.

.4 Legend shall be stenciled, capital block lettering, color as noted in Color Schedule. The size of lettering shall be as follows:

Outside Pipe Diameter (including covering) mm (in)	**Minimum Height of Letters mm (in)**
≤ 50 (≤ 2”)	25 (1”)
65 to 150 (2½” to 6”)	30 (1¼”)
200 to 250 (8” to 10”)	65 (2½”)
≥ 300 (≥ 12”)	90 (3½”)

.5 Directional arrows shall be black stenciled 150mm (6”) long by 50mm (2”) wide for piping 75mm (3”) and larger, and 100mm (4”) long and 25mm (1”) wide for piping 65mm (2½”) and smaller. Double-headed arrows shall be used where the direction of flow is reversible

.6 Legend and directional arrows shall be applied on top of secondary color strip.

.7 Painting contractor to band all exposed or concealed piping except drainage piping and vent piping outside mechanical rooms, under the direction of Division 23 contractor, in the primary color listed in the Color Schedule. Paint bands to completely encircle the pipe for a length of 300mm (12”) in primary color.

.8 Piper markers shall conform to the following:

Outside Pipe Diameter (including covering) mm (in)	**Minimum Length of Label Field Color mm (in)**	**Minimum Height of Letters mm (in)**
20 to 30 (¾” to 1¼”)	200 (8”)	15 (½”)
40 to 50 (1½” to 2”)	200 (8”)	20 (¾”)
65 to 150 (2½” to 6”)	300 (12”)	30 (1¼”)
200 to 250 (8” to 10”)	600 (24”)	65 (2½”)
≥ 300 (≥ 12”)	800 (32”)	90 (3½”)

.9 Field color and lettering color are to be as per the Color Schedule.

.10 All bands shall be neatly arranged and in a straight line across groups of pipes.

.11 Identify piping runs at least once in each room. Do not exceed 15m (50 ft) between identifications in open areas.

.12 All bands, symbols, etc., are to be put in readily visible locations to be seen from floor level. Where piping is partially obscured by other piping and/or equipment, identify on both sides of obscuring equipment.

.13 Where piping passes through walls, partitions and floors, identify on both sides of where it enters and leaves.

.14 Division 23 contractor to apply stencil lettering only after the final finish has been applied.

.15 Where piping is concealed in pipe chase or other confined space, identify at points of entry and leaving and at each access opening.

.16 Identify piping at starting and end points of runs and at each piece of equipment.

.17 Identify piping at major manual and automatic valves immediately upstream of valves.

.18 Natural gas piping shall be painted yellow for the full length.

.19 Use white arrow on red background for fire protection.

.2 Identification Methods

.1 Exposed Piping in Mechanical Room

.1 Apply primary color to all piping in mechanical room in accordance with above requirements.

.2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.

.2 Exposed Piping in Finished Areas

.1 All exposed piping shall be painted in their entirety to match space color scheme. Primary color requirements are waived in these areas.

.2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.

.3 Concealed Piping

.1 No primary color coding required.

.2 Apply secondary banding, legend and direction of flow arrows in accordance with above requirements.

.4 Lettering and Direction of Flow

.1 Lettering: Capital, Bold, Sans Serif, Century Gothic or Helvetica.

.2 For hazardous piping system: black letters and arrows.

.3 Fire protection, other piping systems and ductwork: white letters and arrows, unless otherwise specified.

.5 Miscellaneous

.1 Aluminum jacketed piping shall be identified the same as concealed piping.

.2 Exposed piping in service areas, other than mechanical rooms, shall be identified the same as concealed piping.

.3 Additional requirements for particular piping systems:

.1 Natural gas and propane gas:

.1 Paint complete piping system yellow to CAN/CGAB149.1.

.2 Apply legend and flow arrows after painting.

.2 Fire sprinkler system piping:

.1 Provide system component signs to NFPA 13.

3.5 Manufacturer’s Nameplates

.1 Provide a factory applied nameplate on each piece of manufactured equipment indicating size, equipment name, manufacturer’s name, serial number, electrical characteristics and performance characteristics.

.2 Provide registration plates (such as pressure vessel, ULC and CSA approved plates as required by respective agency and as required by the specifications).

.3 Nameplates of non-Canadian made equipment shall include the name and address of the Canadian agent providing the product.

.4 Mechanically fasten nameplates securely in a conspicuous and easily read location.

.5 Do not apply insulation or paint over nameplates.

3.6 Equipment Identification

.1 The Division 23 contractor shall provide each piece of equipment with a lamacoid plate stating equipment name, system identification and equipment identification number. Lamacoid plates shall be a minimum 3mm thick with black letters on white background. Lettering to be:

.1 Terminal cabinets and control panels: 8mm high lettering

.2 Equipment in mechanical rooms and outdoors: 20 mm high lettering

.3 Equipment located elsewhere: 12mm high lettering

.2 Identify each piece of equipment with the symbol and number to be identified with record drawing equipment name and number.

.3 Equipment which is electrically driven and is identified shall have identical nameplates at the starter.

.4 All nameplates are to be mechanically fastened, easily visible without need to use a ladder or extraordinary body position. Affix additional nameplates if necessary.

.5 Provide the Engineer with an example of the contents of each type of nameplate. Obtain approval prior to engraving.

.6 Submit a complete schedule of all equipment to have identification and the symbol and description to be engraved on the lamacoid plates or stamped brass tags.

.7 Identify as a minimum the following with engraved plastic nameplates:

.1 All mechanical equipment

.2 Computer room cooling units

.3 Electronic thermostats, temperature sensors, humidistats, humidity sensors and CO2 sensors.

.4 Electric starting switches, electric disconnects, remote push buttons and control panels.

3.7 Valve Identification

.1 Division 23 contractor to provide 40mm (1½”) diameter brass tags with 20mm (¾”) engraved lettering and brass jack chain. Secure to items with brass hooks and non-ferrous chains or tie-wraps. Affix a tag to all valves or on piping directly adjacent to the valve.

.2 Valve tags are not required where valves are directly adjacent to the equipment they serve.

.3 Provide neat, typewritten valve location identification charts giving valve tag numbers, valve service and valve location, make/model/size with or without handwheel, type of control and normal position. Frame one copy in metal with acrylic face and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.

.4 Number valves in each system consecutively.

.5 Valve tags shall be provides as follows:

- .1 Tag all valves in mechanical rooms.
- .2 Tag all control valves external to mechanical rooms.
- .3 Tag all circuit balancing valves and isolating valves external to mechanical rooms except valves at terminal heating and cooling equipment.
- .4 Identify and tag thermostats and temperature sensors relating to terminal unit and valve numbers.

3.8 Access Door Identification

.1 Painting contractor to provide under the direction of the Division 23 contractor.

.2 Each access door for concealed equipment such as isolation valves, terminal boxes and coils shall be provided with stenciled number, minimum height shall be 20mm (¾”).

.3 Provide neat, typewritten directory giving access door number, service and location. Frame one copy under glass and mount in equipment room. Provide additional copies for inclusion in each operating and maintenance manual.

3.9 Above Ceiling Equipment Markers

.1 Provide markers in T-bar and drywall type ceilings to identify locations of all dampers, valves and equipment located above the ceilings.

.2 Locate markers on T-bar closed to equipment.

.3 Apply self-adhesive plastic dots, 15mm (½”) diameter, color coded, applied to T-bar ceiling or access door.

.4 Color code as follows:

.1 Yellow – HVAC equipment and duct cleaning access

.2 Red – Fire, smoke and sprinkler equipment

.3 Green – Plumbing equipment and valves

.4 Black – Control dampers and sensors

3.10 Site Painting

.1 Treat exposed uninsulated ductwork with a coat of zinc chromate primer. Apply one (1) coat of anti-corrosive metal primer and two (2) coats of machinery enamel.

.2 Insulated exposed ductwork shall have one (1) coat of latex primer sealer and one (1) coat of flat latex.

.3 Air conditioning and ventilation units, tanks, other units with galvanized finish or stainless steel finish shall not be painted. Apply two (2) coats of machinery enamel to units with prime coat finish.

.4 Paint exposed piping. Finish exposed uninsulated pipes and drainage lines with one (1) coat of metal primer and two (2) coats of machinery enamel which shall be brushed out to a thin even coat, white in color or as selected by architect. Neutralize galvanized pipes with copper sulfate solution prior to painting. Insulated pipes shall have one (1) coat of latex primer sealer and one (1) coat of flat latex, milk white color. Do not paint aluminum jacketed piping except for identification.

.5 After all non-aluminum jacket piping is painted, the mechanical contractor shall direct the painting of color bands on all piping by the painting contractor. The Division 23 contractor shall stencil letters designating the pipe service and direction of flow. The symbol shall be finished in the color code of the mechanical specification.

.6 Steel grilles, diffusers and louvers that are primed only by the mechanical contractor shall have final painting carried out by the painter. Colors will be selected later by the architect from manufacturer’s standard range.

3.11 Visible (Exposed) Ductwork

.1 Paint visible ductwork as directed by Architect. Refer to section 09 91 23 – Interior Painting.

.2 Paint ductwork/flexible connectors that are visible behind grilles/diffusers, matt black. Refer to Section 09 91 23 – Interior Painting.

3.12 Pre-Painted Equipment

.1 Division 23 contractor to repair all pre-painted equipment that has been damaged or has faded.

3.13 Equipment Bases

.1 Equipment bases/housekeeping pads are to be painted grey with 100mm (1”) yellow and black angled bands around the edges.

3.14 Color Code Schedule

.1 Color numbers for Identification Labels on piping systems, valves and equipment are defined in Federal Standard 595C Colors for color code identification

Mechanical Primary Colors for Pipe Lines/Equipment

Black	:	17038
Yellow	:	13591
Green	:	14193
Orange	:	12473
Brown	:	10115
Red	:	11350
White	:	17860
Aluminum	:	16515
Blue	:	15180
Grey	:	16293
Light Blue		15450
Purple		17155

.2 Identification Symbols and Colors for Piping

Fluid	Pipe Color	Lettering Color	WHMIS Symbol	Identification
Domestic Cold Water	Green	White	N/A	DCW
Domestic Hot Water	Green	White	N/A	DHW
Domestic Hot Water Return	Green	White	N/A	DHWR
Fire Sprinkler Water	Red		N/A	
Fire Protection Water	Red		N/A	
Natural Gas	Yellow	Black	Yes	NAT. GAS

Fluid	Pipe Color	Lettering Color	WHMIS Symbol	Identification
Refrigerant Liquid	Blue	White	Yes	REF. LIQ.
Refrigerant Vapor	Blue	White	Yes	REF. VAP.
Sprinkler	Red		N/A	

END OF SECTION

1. General

1.1 Scope

.1 Mechanical contractor coordination with balancing agency.

.2 Balance, adjust, and test air and liquid systems and equipment and submit reports using identical units to those shown on contract documents.

.3 Test operation of the fire dampers.

.4 Bring to the attention of the consultant, any items that are, in the opinion of the balancing agency, installed incorrectly, prior to commencement of balancing procedures.

1.2 Quality Assurance

.1 Work specified in this section shall be performed by an Independent Agency specializing in this type of work. Provide proof that the agency has successfully completed five projects of similar size and scope and is a certified member of Associated Air Balance Council, or similar association. List personnel, and their qualifications, who will be employed during the testing and balancing period.

.2 Balancing (of both air and liquid systems) and sound level readings shall be performed by the same agency.

.3 Balancing procedures shall be in accordance with AABC's "National Standards for Field Management and Instrumentation – Total System Balance", SMACNA, ASHRAE Standards, or other similar procedures.

.4 During the one year warranty period, the owner may request re-check or re-setting of outlets or fans as listed in test report. Provide technicians and equipment required during visits for seasonal adjustments.

1.3 Related Work Specified in Other Sections

.1 Common Work Results for HVAC — Section 23 05 00

1.4 Approved Agencies

.1 Contractor to submit proposed agency for Consultant and Owner approval.

1.5 Mechanical Contractor Responsibilities

.1 Bring the work to an operating state and ready for balancing, including:

   .1 Clean equipment and ductwork.

   .2 Install air terminal devices.

.3 Provide temporary filters in air handling equipment and carry out a rough air balance to ensure all equipment performs required function.

.4 Replace filters with specified filters prior to final balancing.

.5 Verify lubrication of equipment.

.6 Install permanent instrumentation.

.7 Clean piping systems as per 22 01 10.51 – Plumbing Piping Cleaning.

.8 Complete the "start-up" of equipment.

.9 Review packing and seals on all pumps and valves.

.10 Ensure all strainers are clean and complete prior to fluid system balancing (Refer to Section 23 05 23 – General Duty Valves for HVAC Piping).

.11 Check rotation and alignment of rotating equipment and tension of belted drives.

.12 Set control points of automatic apparatus, check-out sequence of operation.

.13 Make available control diagrams and sequence of operation.

.14 Clean work, remove temporary tags, stickers, and coverings.

.15 Make available one (1) copy of Maintenance Manuals especially for use in balancing.

.16 Provide Balancing Agency a complete set of mechanical drawings and specifications.

.2 Cooperate with the Balancing Agency as follows:

.1 Make corrections as required by Balancing Agency.

.2 Allow Balancing Agency free access to site during construction phase. Inform Balancing Agency of any major changes made to systems during construction and provide a complete set of record drawings for their use.

.3 Provide and install any additional balancing valves, dampers, and other materials requested by the balancing agency and/or necessary to properly adjust or correct the systems to design flows.

.4 Provide and install revised pulleys and sheaves for rotating equipment and shave pump impellers, as required to properly balance the systems to design flows. Obtain requirements from balancing agency (Refer to Section 25 05 93 – Testing, Adjusting and Balancing for HVAC Systems).

.5 Operate automatic control system and verify set points during Balancing.

1.6 Site Visits

.1 A review of the installation and access to all valves, dampers, and equipment shall be made at the specified site visits and any additional dampers or valves required for proper balancing shall be forwarded in writing to be reviewed by the Engineer.

.2 Begin balancing after equipment start-up and testing and after systems have been completed and are in full working order. Place systems and equipment into full operation and continue operation during each working day of balancing.

1.7 Balancing Agenda

.1 General: Submit balancing agenda to the Engineer and commissioning contractor for review at least thirty (30) days prior to the start of balancing work. Start balancing work only after agenda has been approved. Include descriptive data, procedure data, and sample forms in agenda.

.2 Descriptive Data: General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed.

.3 Procedure Data: Procedures for converting test measurements to establish compliance with requirements specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.4 Use forms approved by AABC. AABC test sheets required are as follows:

.1 Air Moving Equipment Test Sheet.

.2 Exhaust Fan Test Sheet.

.3 Diffuser and Grille Test Sheet.

.4 Duct Traverse Zone Totals Sheet.

.5 Duct Traverse Readings Sheet.

.5 The total air and water systems shall have the AABC Field Test and Diagnosis Section I through Section VI Form completed.

1.8 Balance Report

.1 Submit (2) copies of rough balancing reports to the Engineer for review, prior to on-site verification and acceptance of Project.

.2 Provide four (4) copies of final reports to contractor for inserting in Owner's Operating and Maintenance Manuals.

.3 General description of each system including associated equipment and different operation cycles, listing of flow and terminal measurements to be performed (selection points for proposed sound measurements).

.4 Procedure Data: Procedures for converting test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch) and correction factors.

.5 Sample Forms: Forms showing application of procedures to typical systems.

.6 Balance Reports:

.1 Submit copies of reports described prior to final acceptance of project. Provide copies for the consultant and for inclusion in Operating and Maintenance Manuals.

.2 Provide reports in soft-cover, three-ring binder manuals, complete with index page and indexing tabs and cover identification at front and side.

.3 Stamp reports by a registered professional engineer certifying adherence to agenda, calculation procedure and final summaries.

.4 Include types, serial number and dates of calibration of instruments.

.7 System Data Reports:

.1 Reports shall include balance and equipment data listed. Report all values in units identical to those specified and shall be shown for design values and actual measured values.

.2 Include schematic diagrams of systems showing final valve, damper and component location and positioning.

.3 Report design and final observed air and water capacities, velocities, etc., including outside air and return air volumes at various damper positions.

.4 Report air temperatures at various mixing damper positions, at inlet and outlet of all heat transfer equipment and at supply terminals.

.5 Report water and glycol temperatures at various mixing valve positions, at inlet and outlet of all heat transfer equipment.

.6 Report static pressure readings at various system operating conditions showing total static, duct static, etc..

.7 Report equipment characteristics at various system operating conditions including, but not limited to, motor name-plate data and actual RPM, adjustable sheave position, fan inlet velocity, filter pressure drop, fan pitch angle, calculation factors for air terminals, etc.

1.9 System Data

.1 Air Handling Equipment

.1 Design Data:

Total air flow rate;

Fan total static pressure;

System static pressure;

Motor kW (HP), r/min, amps, Volts, Phase;

Outside air flow rate L/s (cfm);

Fan r/min;

Fan/kW (HP);

Inlet and outlet, dry and wet bulb temperatures.

.2 Installation Data:

Manufacturer and model;

Size;

Arrangement discharge and class;

Motor type, kW (HP), r/min, voltage, phase, cycles, and load amperage;

Location and local identification data.

.3 Recorded Data:

Supply Air Fan

Fan @ 100% Outside Air

Air flow rate;

Fan total static pressure;

System static pressure;

Fan @ Full Return/Min O/A

Air flow rate;

Fan total static pressure;

System static pressure;

Return Air Fan

<u>Fan @ 100% Exhaust Air</u>

Air flow rate;

Fan total static pressure;

System static pressure;

<u>Fan @ Full Return</u>

Air flow rate;

Fan total static pressure;

System static pressure;

Fan r/min;

For Axial Fans, note blade pitch angle

Motor operating amperage;

Inlet and outlet, dry and wet bulb temperatures.

.2 Duct Air Quantities - All mains supplying more than 10% of Volume, outside air and exhaust (maximum and minimum) major return air openings back to duct shafts.

Duct sizes;

Number of pressure readings;

Sum of velocity measurements;

Average velocity;

Duct recorded air flow rate;

Duct design air flow rate.

.3 Air Inlet and Outlets:

Outlet identification location and designation;

Manufacturers catalogue identification and type;

*Application factors;

Design and recorded velocities;

Design and recorded air flow rates;

Deflector vane or diffuser cone settings.

* (Refer to 3.1.3 for supporting information)

.4 Air Heating and Cooling Equipment

.1 Design Data:

Heat transfer rate;

Liquid and air flow rates;

Liquid pressure drop;

Air static pressure drop;

Entering and leaving liquid temperatures;

Entering and leaving air dry and wet bulb temperatures.

.2 Installation Data:

Manufacturer, model, type;

Entering and leaving fluid flow and temperatures;

Entering and leaving air flow and temperatures;

Fluid and air side pressure drops.

.3 Recorded Data:

Element type and identification (location and designation);

Entering and leaving air dry and wet bulb temperatures;

Entering and leaving water temperatures;

Liquid pressure drop;

Air static pressure drop;

Air and Liquid flow rates;

Adjusted temperature rise or drop.

2. Products

2.1 Instruments

.1 Use accurate instruments for measurements. Use only certified calibration agencies for calibration.

.2 Provide calibration histories for each instrument. Recalibration or use of other instruments may be requested when accuracy of readings is questionable.

3. Execution

3.1 General Procedure

.1 Permanently mark, by stick-on labels and/or fluorescent paint, settings on valves, splitters, dampers, and other adjustment devices.

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

.3 Where vane anemometer is used to measure supply, return or exhaust air grilles, AK factors shall be determined as follows:

.1 Determine and tabulate similar sized grilles being balanced for AK schedule.

.2 Traverse all ducts serving grilles (outlined in AK schedule) to verify AK factors.

.3 AK factor from schedule must be approved by Engineer during initial review with balancer on site. (Balancer shall include written procedure for determination of AK factors).

.4 No flow hoods are to be used for measurement of exhaust or return air grilles.

.4 Balancing shall be performed to the following accuracies:

.1 Air - terminal outlets ±10% (outlets less than 200 L/s (425 CFM))

.2 Air - terminal outlets ±5% (outlets greater than 200 L/s (425 CFM))

.3 Air - central equipment ±5%

.5 Balancing contractor shall advise mechanical contractor of required revised pulleys, sheaves and impeller shavings to allow proper balancing of systems.

.6 Where pump impellers require shaving, this shall be the responsibility of the mechanical contractor. All adjustments shall be by qualified millwright. All changes shall be documented and included as part of the balancing report.

.7 Check and adjust entire system approximately six months after final acceptance. Adjust system if deviations have occurred since balance report acceptance. Submit report.

.8 The work shall also include the following:

.1 Setting of all pressure regulating and reducing valves to operating and code conditions.

.2 Check and setting of all relief and safety valves to code requirements.

.3 Setting of all pump discharge volumes to design conditions.

.4 Balancing of all air flows from fans in ducts, through air outlets to design conditions.

.5 Balancing building systems to maintain designed pressure relationships between various areas.

.9 Test the operation of each fire damper and fire/smoke damper.

3.2 General Air Systems Balancing

.1 All new air systems to be balanced to show air volumes and velocities at main and branch ducts and at all terminals. Fan volumes to be recorded at various mixed air conditions.

.2 Record system air temperatures at various mixed air conditions.

.3 Adjust air flow and terminals to eliminate objectionable air noise at terminal.

.4 Use Pitot tube transverse across entire duct area to measure air flow.

.5 Vary total air system quantities by adjustment of fan speeds.

.6 Where modulating dampers are installed, take measurements at both high and low extremes.

.7 Balance variable volume system to maximum air flow rate with full cooling flow and to minimum air flow rate with full heating flow.

.8 Perform balancing, adjusting, and testing with building doors and windows in their normal operation position.

.9 The following procedure shall be adopted for central systems:

.1 Ensure dampers or volume control devices are in fully open position.

.2 Balance central apparatus to ±5% air flow.

.3 Balance branches and mains in accordance with 3.1.4.

.4 Recheck central apparatus.

.5 Balance all terminal air outlets in accordance with 3.1.4.

.6 Re-balance central apparatus to ±5%.

.7 Recheck all air outlets.

.8 Perform acoustical measurements.

.10 When balancing air outlets:

.1 Rough balance furthest outlets and then balance sequentially back to source.

.2 Fine balance furthest outlet back to source.

.11 Take static pressure readings and air supply temperature readings at 10 points on the system.

.12 Make air quantity measurements in ducts by "Pitot Tube" traverse of entire cross sectional area. Take a minimum of 16 for rectangular ducts, and 10 on each vertical and horizontal axis for round ducts, traverse readings. If readings are inconsistent across duct, try to obtain straight run of six (6) diameters widths upstream and re-do traverse.

3.3 Constant Volume Air Systems Procedure

.1 Check and note the following items on all fans:

.1 Proper fan rotation.

.2 Filter condition (clean or dirty, as specified) where applicable.

.3 Cooling or heat recovery coil condition (dry or wet), where applicable.

.2 Perform air systems balancing for each air system as per AABC specifications as described in the following:

.1 Test and adjust blower RPM to design requirements. Check and set the fan belt tension.

.2 Test and record motor full load amperages and voltage.

.3 Make pilot tube transverse of main supply and obtain design l/s at fans.

.4 Test and record system static pressures, suction and discharge.

.5 Test and adjust system for design l/s recirculated air.

.6 Test and adjust system for design l/s outside air.

.7 Test and record entering air temperatures (db heating and cooling).

.8 Test and record entering air temperatures (wb cooling).

.9 Test and record leaving air temperatures (db heating and cooling).

.10 Test and record leaving air temperatures (wb cooling).

.11 Adjust all main supply and return air ducts to proper design l/s.

.12 Adjust all zones to proper design l/s, supply, return and exhaust. Set constant volume terminal units where applicable.

.13 Test and adjust each diffuser, grille and register to within 5% of design requirements.

.14 Identify each diffuser, grille and register as to location and area.

.15 Identify and list size, type and manufacturer of diffusers, grilles, registers and all testing equipment. Use manufacturer’s rating on all equipment to make required calculations.

.16 In readings and tests of diffusers, grilles and registers, include required m/s velocity and test m/s velocity and required l/s and test l/s after adjustments.

.17 In co-operation with the control manufacturer's representative, set adjustments of automatically operated dampers to operate as specified, indicated and/or noted.

.18 Adjust all diffusers, grilles and registers to minimize drafts in all areas.

.3 Complete balancing to achieve positive building pressure unless otherwise instructed. A positive pressure relative to outside of 10 Pa (0.04" WG) minimum and 20 Pa (0.08" WG) maximum shall be achieved, measured with negligible outside wind velocity.

3.4 Fire Damper/Fire Stop Flap Verification

.1 Visually inspect all fire dampers and fire stop flaps:

.1 Installation is straight.

.2 Wall angles properly installed.

.3 Duct has break away connection.

.4 Fire stopping material where used is properly installed.

.5 Adequate access.

.6 Clearance between sleeve and wall.

.2 Inspect all fire damper blades and tracks prior to test firing. Sheet metal trade to clean all dirty dampers and tracks to satisfaction of balancer.

.3 Manually remove each fusible link to ensure damper blade drops properly, then reset damper. Mark dropped fire damper with black felt marker.

.4 Testing of 10% of the fusible links shall be performed with a suitable heat source capable of generating sufficient heat to detonate fusible link without burning or generating carbon deposits on the blades, frame or adjacent ductwork. Selection of links to be test dropped to be as directed by Engineer. Retesting and resetting shall be witnessed by Engineer.

.5 If fire damper does not close properly, sheet metal trade to repair installation and balancing agency to retest.

.6 All fire damper tests shall be witnessed by two parties, certified by Contractor and endorsed by the testing personnel.

.7 Contact Alberta Building Code enforcement authorities in writing prior to testing each damper and have authorities witness tests as required.

3.5 Balancing and Adjusting of Domestic Water Systems

.1 Adjust PRV on main line to 552 kPa (80 psi) maximum.

.2 Balance domestic hot water recirculating system piping to ensure flow from all points in the system. Ensure all hot and cold supply shut off valves are fully open.

3.6 Balancing Report

.1 Submit draft copies of rough balancing reports prior to final acceptance of project.

.2 Include types, serial number and dates of calibration of instruments.

.3 Record test data on a sepia made from the latest available revised set of mechanical drawings and submit three (3) copies upon completion of the balancing contract for inclusion in equipment and maintenance manuals.

.4 Submit with report, fan and pump curves with operating conditions plotted. Submit grille and diffuser shop drawings and diffusion factors.

.5 Report shall be indexed as follows:

.1 Air

Summary
Procedure
Instrumentation
Drawings
Equipment Summary
Fan Sheets
Fan Curves
Fan Profile Data
Static Data
Air Monitoring Station Data
Traverse Data and Schedule
Terminal Unit Summary
Outlet Data Summary and Schematics (per system)
Building Schematic
Building Pressurization Data
Weather Conditions at Time of Test
Diagnostic
Millwright Reports

.2 Liquid

Summary
Procedure
Instrumentation
Drawings

Pump Data
Pump Curves
Flow Stations
Coils
Equipment Data
Element Data Summary and Schematics (per system)
Diagnostic
Millwright Reports

END OF SECTION

1. General

1.1 Scope

.1 Domestic water systems (hot, cold, recirculation), ambient to 82°C (180°F)

.2 Duct thermal insulation

.3 Duct acoustic insulation

.4 Exterior ductwork

.5 Breeching insulation

.6 Adhesives, tie wires, tapes

.7 Recovery materials

1.2 Reference Documents

.1 American Society for Testing and Materials (ASTM)

1.	ASTM B209M	Specification for Aluminum and Aluminum Alloy Sheet and Plate
2.	ASTM C335	Steady State Heat Transfer Properties of Pipe Insulation
3.	ASTM C411	Hot-Surface Performance of High Temperature Thermal Insulation
4.	ASTM C423	Standard Method for Sound Absorption and Sound Absorption Coefficients by Reverberation Room Method
5.	ASTM C449	Mineral Fiber Hydraulic Setting Thermal Insulating and Finishing Cement
6.	ASTM C533	Calcium Silicate Block and Pipe Thermal Insulation
7.	ASTM C534	Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
8.	ASTM C547	Mineral Fiber Pipe Insulation
9.	ASTM C553	Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications
10.	ASTM C612	Mineral Fiber Block and Board Thermal Insulation
11.	ASTM C921	Practice for Determining the Properties of Jacketing Materials for Thermal Insulation

12.	ASTM C1071	Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)
13.	ASTM G21	Standard of Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi

.2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

1.	ASHRAE Standard 90.1	Energy Standard for Buildings except Low Rise Residential Buildings

.3 Canadian General Standards Board (CGSB):

1.	CAN/CGSB-51.2	Thermal Insulation, Calcium Silicate for Piping, Machinery and Boilers
2.	CAN/CGSB-51.9	Mineral Fiber Thermal Insulation for Piping and Round Ducting
3.	CAN/CGSB-51.10	Mineral Fibre Board Thermal Insulation
4.	CAN/CGSB-51.11	Mineral Fibre Thermal Insulation Blanket
5.	CAN/CGSB-51.12-M86	Thermal Insulating and Finishing Cement
6.	CAN/CGSB-51.53	Poly (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts
7.	CGSB 51-GP-52Ma	Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation

.4 National Fire Protection Association (NFPA):

1.	NFPA 255	Standard Method of Test of Surface Burning Characteristics of Building Materials

.5 National Research Council of Canada

.1 National Energy Code of Canada for Buildings (NECB) 2011

.6 Thermal Insulation Association of Canada (TIAC)

.1 Mechanical Insulation Best Practices Guide.

.7 Underwriters Laboratories Canada (ULC)

1.	CAN/ULC-S102	Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
2.	CAN/ULC-S701	Thermal Insulation, Polystyrene, Boards and Pipe

1.3 Submittals

.1 Product Data

.1 Submit manufacturer's product data in accordance with Section 01 33 00 – Product Submissions, and Section 23 05 00 – Common Work Results for HVAC.

.1 Submit product data and test reports when requested to substantiate that insulation and recovery assemblies meet flame/smoke development ratings and performance requirements for the assembly and thickness used.

.2 Submit information showing installed insulation and membrane products meet the requirements of ASHRAE 90.1.

.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01 33 00 – Product Submissions, and Section 23 05 00 – Common Work Results for HVAC.

.1 For each application submit an insulation schedule to include the following information:

.1 Materials

.2 "k" value

.3 Thickness

.4 Density

.5 Finish

.6 Jacketing

.3 Submit information showing installed insulation and membrane products meet the requirements of the National Energy Code of Canada for Buildings 2011 and ASHRAE 90.1-2010.

1.4 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Related Work Specified in Other Sections

.1	Common Work Results for HVAC	Section 23 05 00
.2	Plumbing	Division 22
.3	Heating, Ventilation and Air Conditioning	Division 23

1.7 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of work.

.2 Materials shall meet fire and smoke hazard ratings as stated in this section and defined in applicable building codes.

1.8 Product Options and Substitutions

.1 Refer to Division 01 for requirements pertaining to product options and substitutions.

.2 Alternative insulations are subject to approval. Alternatives shall provide the same thermal resistance within 5%, at normal conditions as material specified.

1.9 Definitions

.1 For the purposes of this Section, the following definitions apply:

.1 Concealed: Piping, ductwork or equipment in trenches, shafts, furring, and suspended ceilings.

.2 Exposed: Piping, ductwork or equipment in mechanical rooms or otherwise not "concealed".

.3 "k" Value: Thermal conductivity of insulating material per unit of thickness (W/m.°C).

1.10 Flame/Smoke Development Ratings

.1 Insulation materials, recovery materials, vapor barrier facings, tapes and adhesives shall have maximum flame spread rating of 25 and maximum smoke developed rating of 50, when tested in accordance with CAN/ULC-S102. Materials required which do not meet this rating must be treated on site with finish which will provide necessary ratings.

.2 Insulating materials and accessories shall withstand service temperatures without smoldering, glowing, smoking or flaming when tested in accordance with ASTM C411.

.3 ULC or ULI label or listing or satisfactory certified report form an approved testing laboratory will be required to indicate that the fire hazard ratings for materials proposed for used do not exceed those specified.

1.11 Job Conditions

.1 Deliver material to job site in original non-broken factory packaging, labelled with manufacturer's density and thickness.

.2 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, poor workmanship, or material defects.

2. Products

2.1 Acceptable Manufacturers

1.	Insulation	:	Owen's Corning/Fiberglas Canada Inc., Manson, Knauf Fiberglass, Ottawa Fibre
2.	Adhesives and Coatings	:	Bakor, 3M Company, Durodyne, Benjamin Foster
3.	Sealants	:	Dow Corning, Tremco

2.2 General

.1 Flame proofing treatments subject to deterioration due to the effects of moisture or high humidity are not acceptable.

.2 All adhesives, sealers, vapor coatings, etc., shall be compatible with the materials to which they are applied and shall not deteriorate insulation material.

.3 All insulation materials shall meet Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

2.3 Hot Pipe Insulation

.1 Hot Pipe Insulation – Mineral Fiber

.1 Material: Formed rigid mineral fibre insulation sleeving to ASTM C547.

.2 "k" Value: Maximum 0.035 W/m.°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: Up to 150°C (300°F)

.4 Jacket: Factory applied general purpose jacket.

.2 Hot Pipe Insulation - Black Rubber:

.1 Material: Flexible elastomeric unicellular preformed pipe covering to ASTM C534.

.2 "k" Value: 0.04 W/m. °C at 24°C

.3 Service Temperature: Up to 100°C (212°F)

.4 Maximum Allowable Thickness: 25mm (1”)

2.4 Cold Pipe Insulation

.1 Cold Pipe Insulation: Mineral Fiber:

.1 Material: Formed mineral fibre rigid insulation sleeving to ASTM C547.

.2 "k" Value: Maximum 0.035 W/m.°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: -14°C to 100°C (7°F to 212°F)

.4 Jacket: Factory applied vapor barrier jacket to CGSB 51-GP-52Ma, Type 1, with longitudinal lap seal.

.2 Cold Pipe Insulation - Black Rubber:

.1 Material: flexible elastomeric unicellular preformed pipe covering to ASTM C534.

.2 "k" Value: 0.04 W/m. °C at 24°C

.3 Service Temperature: -14°C to 100°C (7°F to 212°F)

.4 Maximum Allowable Thickness: 25mm (1”)

2.5 Hot Duct Insulation

.1 Hot Duct Insulation - Round and Oval:

.1 Material: Flexible mineral fiber blanket insulation to ASTM C553 faced with factory applied vapor retarder jacket to CGSB 51-GP-52Ma.

.2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: 20°C to 65°C (68°F to 149°F)

.2 Hot Duct Insulation - Rectangular

.1 Material: Rigid mineral fiber insulation to ASTM C612 with factory applied vapor retarder jacket to CGSB 51-GP-51Ma.

.2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: 20°C to 65°C (68°F to 149°F)

2.6 Cold Duct Insulation

.1 Cold Duct Insulation - Round and Oval:

.1 Material: Flexible mineral fiber blanket insulation to CAN/CGSB-51.11.

.2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: -40°C to 65°C (-40°F to 150°F)

.4 Jacket: factory applied reinforced aluminum foil vapour barrier to CGSB 51-GP-52Ma.

.2 Cold Duct Insulation - Round (Exposed to Outdoors):

.1 Material: Semi-rigid mineral fiber in roll form.

.2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: -40°C to 65°C (-40°F to 150°F)

.4 Jacket: Factory applied reinforced aluminum foil vapor barrier to CGSB 51-GP-52Ma.

.3 Cold Duct Insulation - Rectangular:

.1 Material: Rigid mineral fiber insulation to CAN/CGSB-51.10.

.2 "k" Value: Maximum 0.035 W/m/°C at 24°C (0.24 btu in/hr/ft^2 at 75°F)

.3 Service Temperature: -40°C to 65°C (-40°F to 150°F)

.4 Jacket: Factory applied reinforced aluminum foil vapor barrier to CGSB 51-GP-52Ma.

2.7 Acoustic Ductwork Insulation

.1 Material: Rigid mineral fiber acoustical insulation to ASTM C1071, Type 2

.2 Density: 48 kg/m^3 (minimum)

.3 Acoustic Properties: Minimum NRC of 0.70 for 25mm thickness based on Type A mounting to ASTM C423

.4 "k" Value: maximum 0.035 W/m°C at 24°C (0.24 btu in/hr/ft2 at 75°F) when tested in accordance with ASTM C177

.5 Service Temperature: -40°C to 65°C (-40°F to 150°F)

.6 Surface Finish: Absolute roughness of exposed surface not to exceed 0.58mm (26 gauge), coated to prevent fibre erosion at air velocities up to 25.4 m/s (5000 ft/m)

2.8 Breeching Insulation

.1 Material: Semi-rigid mineral fibre with glass mat.

.2 "k" Value: Maximum 0.035 W/m°C at 24°C (0.24 btu in/hr/ft2 maximum at 75°F)

.3 Service Temperature: 65°C to 450°C (150°F to 840°F)

2.9 Accessories

.1 For mineral fiber insulation materials:

.1 FSK Tape: vapor barrier tape consisting of laminated aluminum foil, glass fiber scrim and paper, with pressure sensitive self-adhesive.

.2 ASJ Tape: vapor resistant tape consisting of all service jacket material with pressure sensitive self-adhesive.

.3 Adhesive: quick setting adhesive for joints and lap sealing.

.2 Black Rubber Insulation Adhesive: Manufacturers recommended contact cement.

.3 Lap Seal Adhesive: Quick setting adhesive for joints and lap sealing of vapor barriers.

.4 Canvas Adhesive: Dilute, washable, fire retardant lagging adhesive for cementing canvas jacket to duct insulation.

.5 Pins: Welding pins 4mm (0.15”) diameter shaft with 35mm (1½”) diameter head for installation through the insulation. Length to suit thickness of insulation with 35mm (1½”) square nylon retaining clips.

.6 Thermal Insulating and Finishing Cement: To ASTM C449 mineral fiber hydraulic setting thermal insulating and finishing cement for use up to 650°C (1200°F).

2.10 Recovery Materials

.1 Canvas: ULC listed, 220g/m² plain weave cotton fabric treated with fire retardant lagging adhesive to ASTM C921.

.2 Aluminum: ASTM B209, 0.5mm (0.02”) thick smooth with longitudinal slip joints and 50mm (2”) end laps, 0.4mm (0.015”) thick die shaped fitting covers with factory attached protective liner on interior surface.

.3 PVC: To CAN/CGSB-51.53-95, 0.38mm (0.015”) thick for interior use and 0.57mm (0.022”) thick for exterior use, off-white in color with one-piece premoulded fitting covers.

.4 Black Rubber Finish: Insulation manufacturers recommended vinyl lacquer type coating.

3. Execution

3.1 Installation - General

.1 Do not install insulation until after the required piping, ductwork and equipment tests have been completed, witnessed and certified.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions, where possible.

.3 Install in accordance with TIAC National Standards and manufacturer’s recommendations.

.4 Ensure insulation is continuous through floor and wall sleeves etc. Pack around piping and ducts with fireproof self-supporting insulation materials, properly sealed.

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

.6 Install insulation at ambient temperatures within acceptable temperature ratings for tapes, sealants and adhesives.

.7 Apply insulation to provide smooth and even finish, uniform diameter, no sagging, wrinkling, etc.

.8 A complete moisture and vapor seal shall be provided wherever insulation terminates against metal hangers, anchors and other projections through insulation and cold surfaces for which vapor seal is specified.

3.2 <u>Installation – Pipe Insulation</u>

.1 On vertical piping with diameters 25mm (1”) and larger, use insulation supports welded or bolted to pipe directly above lowest pipe fitting. Repeat supports on 4.5m (14 ft) centers and at each valve and flange.

.2 Tightly fit insulation sections to pipe to make smooth and even surfaces. Cut insulation for proper fit where weld beads protrude. Bevel away from studs and nuts to allow their removal without damage to insulation. Trim closely and neatly around extending parts of pipe saddles, supports, hangers, clamp guides and seal with insulating/finishing cement.

3.3 <u>Installation – Duct Insulation</u>

.1 Insulated in their entirety are all combustion air and relief air ductwork, all exhaust air ductwork for a distance of 5m (16 ft) from the exterior walls or openings, ductwork carrying hot or cold conditioned air and outside air ductwork.

.2 Unless otherwise indicated, do not insulate ducts carrying air at room ambient temperature, exhaust air ductwork except as noted above, return air ductwork, relief air ductwork and ductwork fitted with an approved acoustic thermal lining.

.3 Do not insulate ductwork with external thermal insulation where acoustic duct insulation is specified or indicated.

.4 Add extra thickness of insulation at standing seams, flanged joints and any other duct protrusions. Adhere jacket lap joints with an adhesive which will be guaranteed to maintain the adhesion under all conditions.

.5 Ductwork carrying outside air must be insulated completely so there is no break in either the insulation thickness or vapor barrier.

.6 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.

.7 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200mm (8”) centers. Longitudinal slip joints, lap circumferential joints 75mm (3”) minimum and seal all joints with compatible waterproof lap cement.

.8 Where duct velocities exceed 10m/s (2000ft/m), cover insulation with 0.8mm perforated galvanized steel with 24% free area.

.9 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.

.10 Stagger butt joints where multi-layered insulation is used.

.11 Butt duct insulation at top of duct. Stagger all joints where more than one layer of insulation is used. Tape all insulation joints neatly.

.12 Straps or twin ties used to secure insulation shall not unduly compress the insulation. Sagging of duct insulation is also not allowed.

3.4 Hot Pipe Insulation Application

.1 Apply mineral fiber insulation when pipe surface temperatures are 50°C to 60°C (122°F to 140°F).

.2 Apply mineral fiber insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Seal butt joints with 100mm (4”) wide ASJ tape.

.3 Terminate mineral fiber insulation at each end of unions and flanges. Trowel finishing cement into bevel.

.4 Cover fittings and valves with equivalent thickness of finishing cement. Apply finishing cement over exposed fittings and valves before applying canvas recovering. Insulate with tightly placed flexible insulation and apply PVC fitting covers.

.5 Cut mineral fibre insulation layers straight on 10m (32 ft) centers with 25mm (1”) gap to allow for expansion between terminations. Pack void tightly with insulation and protect joints with aluminum sleeves.

.6 Seal black rubber insulation butt joints and seams with black rubber insulation adhesive.

.7 Recover exposed mineral fiber insulated piping with PVC.

.8 Recover mineral fibre insulated piping exposed to outdoors with waterproof aluminum jacket.

.9 Coat exposed black rubber insulation with two coats of black rubber finish material.

.10 Do not insulate the following piping system components:

.1 Unions, flanges, strainers, expansion joints, flexible piping connectors.

.2 Condensate trap assemblies and drip legs.

.3 Valve bonnets on domestic water systems.

.4 Drains, plugs and caps.

3.5 Cold Pipe Insulation Applications

.1 Insulate 5m (15 ft) portion of plumbing vents measured from roof outlet back. Do not insulate remaining vent piping.

.2 Insulate storm sewer piping for its entire length with 12mm (½") thick insulation. Insulate final 5m (15 ft) portion measured back from roof drain with 25mm (1") thick insulation.

.3 Apply vapor retardant mineral fiber insulation and recovery over full length of pipe without penetration of hangers, interruption at sleeves and fittings. Apply adhesive to ends of butt joints and seal joint seams with 100mm (4") wide strips of joint tape.

.4 Insulate complete system including valves, unions, flanges, strainers, drains, caps and fittings. Cover fittings and valves with equivalent thickness of finishing cement. Cover finishing cement with open mesh glass cloth and vapor retardant adhesive. Seal lap joints with 100% coverage of joint tape and seal the assembly with vapor retardant adhesive. Alternatively, insulate with tightly placed flexible insulation and apply reinforcing membrane embedded in vapor retardant coating and apply PVC fitting covers.

.5 Seal black rubber insulation butt joints and seams with black rubber insulation adhesive.

.6 Recover exposed mineral fiber insulated piping with PVC.

.7 Recover mineral fiber insulated piping exposed to outdoors with aluminum.

.8 Coat exposed black rubber insulation with two coats of black rubber finish material.

3.6 Hot Duct Insulation Application

.1 Adhere insulation to round and oval ductwork with contact adhesive applied in 150mm (6") wide strips on 400mm (16") centers. Band on outside with wire until adhesive has set.

.2 Butt insulation and seal joints with lap seal adhesive; cover joint ASJ tape.

.3 Secure rigid insulation on rectangular ducts with 50% area coverage using contact adhesive, impale on pins located 400mm (16") on centre, secure in place with retaining clips.

.4 Butt rigid insulation on rectangular ducts and seal joints with lap seal adhesive; cover joints with 100mm (4”) strips of open mesh cloth imbedded between two coats of lap seal adhesive.

3.7 Cold Duct Insulation Application

.1 Adhere mineral fiber insulation to round and oval ductwork with adhesive applied in 150mm (6”) wide strips on 400mm (16”) centers. Band on outside until mastic sets then remove bands.

.2 Butt mineral fiber insulation and seal joints with lap seal adhesive; cover joint with FSK tape.

.3 Secure rigid insulation on rectangular ducts with 50% area coverage of adhesive and impale on pins located 400mm (16”) on centre and secure in place with the retaining clips.

.4 Butt rigid insulation on rectangular ducts and seal joints with lap seal adhesive; cover joints with 100mm (4”) strips of open mesh cloth imbedded between two coats of lap seal adhesive.

3.8 Acoustic Duct Insulation Applications

.1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.

.2 Install in accordance with manufacturer’s recommendations, and as follows:

.1 Fasten to interior sheet metal surface with 100% coverage of adhesive.

.2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425mm (17”) on centers.

.3 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer’s written recommendations, and as follows:

.1 Bed tape in sealer.

.2 Apply two coats of sealer over tape.

.4 Replace damaged areas of liner at discretion of the Engineer.

.5 Protect leading and trailing edges of duct sections with sheet metal nosing having 15mm (½”) overlap and fastened to duct.

3.9 Exposed Ducts Application

.1 Make smooth any uneven insulated surface before recovering.

.2 Finish exposed ducts with canvas jacket suitable for paint finish.

.3 Finish ducts exposed to outdoors with aluminum jacket. Caulk all joints on jacket for weather tight finish. Locate longitudinal joints in least weather exposed position.

3.10 Breeching Insulation Application

.1 Face breeching with 9.5mm (0.37”) rib lath turn out to provide 12 mm space between insulation and hot surface and 12.5mm (½”) mesh expanded lath on the outside.

.2 Butt insulation firmly together and secure with 1.6mm (0.06”) galvanized wire.

.3 Lace metal mesh together. Coat with 12mm (½”) thick finishing cement. Finish with a final 12mm (½”) coat of finishing cement with 25% by weight of Portland cement. Trowel to a smooth hard finish.

.4 Recover with aluminum jacket. Fasten aluminum recovery jacket in place with 12mm (½”) wide stainless steel banding on 300mm (12”) centers or screws or rivets on 150mm (6”) centers. Lap longitudinal slip joints by 50mm (2”).

3.11 Exterior Ductwork

.1 Insulate with 50mm thick insulation (type D-1 for rectangular, type D-2 for round). Apply two (2) coats of 3-2mm thick asphalt (Bakor C17 or Childers CP.10) with glass reinforced fabric (Bakor or ChilGlas #5) in between layers and lapping a minimum of 50mm. Cover with Bakor C17 or Childers CP.10 asphalt base. Seal and make tight all connections. Recover with aluminum jacketing.

3.12 Insulation Installation Thickness Schedule – Piping

	Piping	Pipe Sizes mm (in)	Insulation Thickness mm (in)	Recovery Jacket
1.	Domestic Cold Water Piping	40 (1½”) & under 50 (2”) & over	15 (½”) 25 (1”)	Canvas
2.	Domestic Hot Water Supply & Recirculation Piping	50 (2”) & under 65 (2½”) & over	25 (1”) 40 (1½”)	Canvas
3.	Domestic Hot Water Supply & Recirculation Piping (Non-conditioned Space or Outside)	50 (2”) & under 65 to 100 (2½” to 4”) 150 (6”) & over	65 (2½”) 75 (3”) 89 (3½”)	Canvas or Aluminum Jacketing (Outside)
4.	Roof Drains, Vertical Connections Below Roof Drains and 3m (10’-0”) of Horizontal Piping	All sizes	25 (1”)	Canvas
5.	Vents within 3m (10’-0”) of Roof Outlet	All sizes	25 (1”)	Canvas

	Piping	Pipe Sizes mm (in)	Insulation Thickness mm (in)	Recovery Jacket
6.	Refrigerant Suction Piping	All sizes	20 (¾”)	Aluminum

3.13 Insulation Installation Thickness Schedule – Ducting

	Ducts & Equipment	Insulation Thickness mm (in)	Recovery Jacket
1.	Combustion Air and Relief Duct	50 (2”)	Canvas
2.	Exhaust Ducts within 3m (10’-0”) of Exterior Walls or Openings.	25 (1”)	Canvas
3.	Outside Air Intake Ducts	50 (2”)	Canvas
4.	Ductwork exposed to outdoors	50 (2”)	Aluminum
5.	Ductwork exposed to outdoors with acoustic lining	50 (2”) (Acoustic)	-
6.	Supply Ducts (Heating / Cooling System)	25 (1”)	Canvas
7.	Supply Ducts Ventilation Systems	25 (1”)	Canvas
8.	Ventilation Equipment Casings	25 (1”)	Canvas
9.	Acoustic Lining (where indicated)	25 (1”) (unless indicated otherwise)	-
10.	Domestic hot water breeching (forced air burners)	50 (2”)	Aluminum
11.	Indirect gas fired unit heaters breeching (forced air burners)	50 (2”)	Aluminum
12.	Ventilation equipment	50 (2”)	Canvas

END OF SECTION

1. General

1.1 Scope

.1 Provide all materials and services as documented within these specifications and as required to furnish a complete and fully operational DDC Building Automation System (BAS) to monitor and control the building systems referred to in this specification.

.2 The work includes the supply and installation of DDC controllers, instrumentation, control devices, conduit, wiring, tubing and other devices as necessary to provide a complete system of BAS controls, compliant with these specifications.

.3 Supply, install and configure all software, programming and databases; set up equipment operating schedules; and perform system activation functions as identified within these specifications, to provide a complete and fully operational BAS.

.4 Provide:

- .1 Submittals,
- .2 System Documentation,
- .3 Acceptance Testing, and
- .4 Instructions to Owners

1.2 Related Work

.1	Instrumentation and Control Devices for HVAC	Section 23 09 13
.2	Sequence of Operations for HVAC Controls	Section 23 09 93.1
.3	Point Schedules for HVAC Controls	Section 23 09 93.2

1.3 Work by Others

.1 Distribution and installation of wells, flow insertion fittings, motorized valves and motorized dampers into the piping systems.

1.4 Quality Assurance

.1 Provide a complete system of BAS controls for mechanical systems by specialty BAS firms having proof of completing three (3) projects of similar size.

.2 The BAS equipment shall be of one manufacturer throughout and shall have service for the system from manufacturer’s factory authorized service, resident in the City of Edmonton, Red Deer or Calgary.

.3 Software engineering and support shall be resident in the City of Edmonton, Red Deer or Calgary.

1.5 Shop Drawings

.1 Submit shop drawings in accordance with Section 23 05 05 and with the requirements outlined below.

.2 Submit the shop drawings and technical data describing the proposed system within 90 days after award of the BAS contract. Provide sufficient detail to enable the consultant to evaluate the proposed system and determine whether the requirements of the specification will be met.

  .1 Schematic of system architecture indicating the type and location of all digital controllers, the major system equipment monitored and controlled by each panel and how the controllers are to be networked.

  .2 The proposed digital I/O points list including at a minimum the point mnemonic, point description, controller number and controller I/O point number.

  .3 Equipment schedule for all hardware, valves, dampers, field instrumentation, input/output devices, transducers and actuators.

  .4 Technical description and specifications for the primary and sub-networks.

  .5 Schematic diagram for each mechanical system showing all input/output points, wiring diagrams for all I/O points and a written detailed operational description of control sequences. For terminal equipment controllers, submission of field point wiring diagrams for each type is adequate.

  .6 Engineering/technical data and maintenance information for each system component, including sizing and arrangements as requested. Include calculations for control valve selections.

.3 Shop drawings are to be submitted in an organized fashion complete with table of contents, tab sheets and sequentially numbered pages to enable easy location of information. This also applies to component data sheets.

.4 Component data sheets shall be organized by device type with tab sheets for each section i.e. Controllers, Digital Input devices, Digital output devices, Analog input devices, Analog output devices.

.5 The table of contents for component data sheets must indicate product description, specification I/O device type or specification section, and page number.

.6 Component specification sheets that include more than one product shall be clearly marked to identify the applicable product(s), options and specifications.

.7 Submit copies of the complete shop drawings to the consultant for review and approval. Partial submissions may be accepted depending on the detail and acceptance by the

Consultant. Provide additional copies of the complete approved shop drawings with the O&M Manuals.

.8 Within 120 days after award of the contract submit printed copies of all dynamic graphic displays, proposed calibration check sheets.

.9 Within 180 days after award of the contract submit two (2) draft Operating and Maintenance manuals as specified in this section under System Documentation.

.10 BAS shop drawings shall be based on approved mechanical equipment shop drawings. The Mechanical Contractor is to provide approved mechanical equipment shop drawings to the BAS Contractor.

1.6 Owner Orientation

.1 Formal training sessions shall commence only after "as-built" drawings have been completed, reviewed and approved by the Engineer.

.2 Individuals who have had specific training as an instructor shall conduct training sessions.

.3 All training sessions shall include training materials and shall follow a documented course outline.

.4 A copy of the training materials, which shall include a detailed course outline, shall be submitted to the Engineer for approval three weeks prior to commencing any training sessions.

.5 Any training conducted without prior approval of the Engineer shall be repeated at the discretion of the Engineer and/or will not count toward the contractors training obligations.

.6 The BAS contractor shall provide three weeks written notice to the Engineer and building Owner prior to commencing formal training sessions.

.7 The BAS contractor shall provide three (3) complete sets of training manuals to the Owner prior to commencing of the training session, plus one manual to the Engineer.

.8 Provide for operator training according to the following schedule.

- .1 A one (1) day system and component familiarization seminar/workshop during the first week of trial usage.
- .2 A one (1) day seminar/workshop the week before the 7-day acceptance test covering all aspects of system use as follows:
  - .1 Operation of hardware components
  - .2 System software configuration

.3 User/system interaction

.4 Calibration of sensors and system

.5 Trouble shooting of system and components

.6 Preventative maintenance

.3 A one (1) day review workshop at one month after system acceptance.

1.7 Warranty

.1 Include warranty provisions identified in the specifications.

.2 In addition to the warranty in item .1, provide a two (2) year warranty on all items provided under this contract including but not limited to all equipment, wiring and software. The warranty period shall commence on the date of final written acceptance of the BAS system.

.3 Provide on site service including all labor, materials and software to maintain the complete control system in optimal functioning condition during the warranty period.

.4 Perform preventive maintenance (PM) during the warranty period.

.5 In addition to warranty call backs provide two (2) service and calibration inspections of a minimum four (4) of hours duration each. These calls will be initiated by the Owner.

.6 The overtime premiums for weekend and overtime service calls shall be clearly identified within your proposal.

.7 The BAS contractor shall supply and install at no cost all system software updates and upgrades occurring up to 2 months prior to the expiration of the warranty period.

.8 Maintain a service log on site of all control system maintenance activities during the warranty period.

1.8 System Activation

.1 Submit control calibration and point verification check sheets to the Engineer for approval prior to any calibration of devices or end to end point verification commences. Check sheets to include:

.1 Controller identification number

.2 Controller input/output point number

.3 Control point mnemonic

.4 A complete concise English description of each point

.5 Device controlled

.6 Interlock devices

.7 Measured and displayed analog input values

.8 Analog Output zero and full scale verification

.9 End to End verification for all points

.10 Wire labels verification

.11 Device tag verification

.12 Date of verification

.13 Initials of person performing verification

.2 Submit sample control loop trend log plot, of the type to be used for demonstrating control loop tuning, to the Engineer for approval.

.3 Verify that each hardware component has been properly installed as recommended by the manufacturer and is functioning correctly.

.4 Calibrate all devices including sensors, transmitters, transducers, current relays, valve actuators, damper motors, etc., verifying that end to end calibration accuracy as specified has been achieved.

.5 Ensure tight shut off and fail safe operation of valves and dampers. Hysteresis shall not be greater than 5% of the operating range.

.6 Set damper linkages, static pressure/volume controls as required.

.7 Set up run time capture for each digital input point.

.8 Set up alarm point for each digital input/output pair, with delay before alarm is annunciated.

.9 Set up deviation alarm for each control loop measured variable input with appropriate alarm interlocks, dead-bands and time delays.

.10 Set up high and low alarm limit points for analog input points as shown on the point list.

.11 Set up zero scale and full scale alarms for each analog input to alarm point failures.

1.9 Acceptance Testing

.1 A final operational acceptance test of seven consecutive days shall be conducted on the complete and total installed and operational control system to demonstrate that it is functioning properly in accordance with the specifications.

.2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control programs and algorithms, diagnostics and all other software. Specific testing shall include but not be limited to:

  .1 Power Failure Restart.

  .2 Outside Air Temperature Reset Schedules

  .3 Night Setback

  .4 Free Cooling

  .5 Mechanical Cooling

  .6 Mechanical Heating

.3 In the event of the failure of function, during the test, of any of the hardware components or software application or routines, the test will recommence and run until seven failure-free test days have occurred.

.4 Prior to conducting the final operational acceptance testing, submit to the Engineer:

  .1 Completed calibration and verification check sheets including airflow station calibration sheets.

  .2 Hard copy and electronic copy on CD of final data base listings.

  .3 If electronic copy of final database listing is not in Microsoft Word, Excel or Access format, provide a final points list to the Engineer in either Microsoft Word, Excel, or Access format.

  .4 Hardcopy of all system Graphics.

  .5 A signed declaration stating that all work has been completed or identifying any outstanding deficiencies and the anticipated completion date(s).

.5 After successful completion of the acceptance test, the Engineer will issue written acceptance of the control system.

.6 For all systems prior to substantial completion the BAS contractor shall successfully demonstrate the response to

  .1 All fire alarm interlocks, shut-down sequences and fire control strategies

  .2 All power failure interruptions

.7 The initiation of the Fire Alarm system into alarm mode and simulation or tripping of the main power feeders shall be performed by others.

1.10 System Documentation

.1 Operating and Maintenance Manuals

.1 The BAS Operation and Maintenance Manuals shall contain operational, product data, cleaning and maintenance information on all products and equipment supplied as part of this projects BAS. The final Manuals shall accompany the Project Record Drawings and shall be in place prior to substantial performance.

.2 Submit a draft Manual for format review three (3) months after award of Contract and three (3) Manuals of Documentation for interim submission at 75% construction. Draft Manuals are to be complete in all aspects less control programming. Interim submission is to include all control shop drawings, programming and system descriptions. Draft and Interim Manuals are to be submitted in 3 ring binders. Final Manuals to be in catalogue type binder.

.3 Each manual shall be 215 mm x 280 mm capacity extension type Catalogue Binder bound in heavyweight fabricord, colour to be reviewed with the Owner prior to order and hot stamped in white lettering front and spine.

.4 The spine and front face of the binder shall be lettered with the following:

.1 Full identification title of the project

.2 Building Automation System

.3 Operation and Maintenance Manual

.4 Set X of Y

.5 Volume X of Y

.5 The manual shall be arranged according to the following format. Utilize colour coded laminated mylar plastic divider tabs with headings according to section.

.1 Table of Contents

.2 Introduction

.3 Control System Design

.4 Building System Descriptions

.5 DDC Panel Layout

.6 Shop Drawings

.7 Equipment Schedules

.8 Certification and Testing

.9 Product Manuals

.10 Maintenance

.11 Software & Certificates

.6 On the first page of each binder, before the table of contents identify the following:

.1 Prime Consultant: name, address, telephone number.

.2 Contractor: name, address, telephone number.

.3 Subcontractors: name address, telephone number.

.7 Table of Contents

.1 Include in each binder a table of contents that provides an index in order of appearance of all sections and subsections within the manual.

.8 Introduction

.1 Provide a written explanation of the layout of the manual.

.2 List all other control system manuals submitted for this project including all software manuals and hardware manuals. Identify the quantities of each manual provided.

.9 Control System Design

.1 Design Intent

.1 Explain, in this section, the design intent and give a system overview which outlines the relationships between the hardware, operating system, control software and other control components.

.2 Provide a detailed description of all parts, components and software in the system.

.3 Describe the system architecture. Provide a system configuration schematic with the location, type and model of all control panels, work stations, remote access modems, etc. and identify the major equipment monitored and controlled by each panel.

.4 The schematic must identify network communication protocols and communication speeds between all control panels and indicate BACnet compatibility where applicable.

.5 Identify the number of controllers that can be added to each network and sub-network and any maximum distance between controllers or maximum length of network without the need to add additional communication devices.

.6 Identify all software products provided including third party software. This shall include but not be limited to all operator workstation, graphics, controller and laptop software. For each product, indicate the number of software licenses provided, the name of the respective vendor and any software protection devices required. Indicate the number of software protection devices provided.

.2 Operations

.1 Provide an overview of the building automation system operations. Include basic instruction on:

.1 System access

.2 Alarms management (including, how and where alarms are annunciated, after-hours reporting of critical alarms, etc.)

.3 Commonly used reports

.4 Laptop, local and remote system access and

.5 Basic trouble shooting directions.

.2 These instructions are to provide a basic understanding of the system operations and are to reference specific areas of the software manuals for further detailed instructions.

.3 Provide detailed back-up and data recovery procedures including recommended frequencies and data to be backed up. Here again refer to specific areas of product manuals where appropriate. Provide sample back-up log sheets.

.10 Building System Descriptions

.1 System Design intent - Explain, in this section, the design intent and give a system overview which outlines the system components and the intended system function.

.2 Provide a schematic, control sequences, wiring diagram, device list and points list for each building system controlled by the BAS.

.3 Control sequences shall identify start-up and shut-down sequences, control loop set-points, reset schedules, system interlocks, etc.

.4 As built record drawings in 11” X 17” format, folded to fit into the O&M binders may be used to provide part or all of the information required for this section.

.11 DDC Panel Layout

.1 Provide as-built panel layout sheets and include locations of all panels.

.2 Include a panel points list that identifies each point name with concise English description and termination point. Identify panel spare points.

.3 Identify power source for each panel including emergency/normal, UPS, panel number and circuit number.

.12 Shop Drawings

.1 Insert in this section all approved shop drawings organized in the format specified in section 23 05 05 – Documentation for HVAC Systems.

.13 Equipment Schedules

.1 Provide an equipment schedule for all hardware provided including valves, dampers, actuators, controllers, transducers, input/output devices and other instrumentation.

.14 Certification and Testing

.1 Provide final copies of all completed calibration and verification check sheets including all airflow station calibration check sheets.

.15 Product Manuals

.1 Include in this manual or within product, user manuals and technical manuals, complete and detailed instruction on the use, setup and support of all control system software and hardware provided under this project.

.2 Provide detailed instructions on set-up and user operations including but not limited to system access, navigation, alarms, trending, historical trending, reporting and trouble shooting.

.3 Provide complete detailed instruction on database structure, set-up, initialization, expansion and editing.

.4 Provide complete detailed instruction to enable creation, modification and implementation of control sequences.

.16 Maintenance

.1 Provide a description in this section of maintenance procedures for all equipment and systems, as defined in this specification, including a schedule for recommended planned and preventative maintenance work items and intervals.

.2 Include a preventative maintenance program complete with suggested check list sheets.

.3 Provide a list of resources to call upon for maintenance and servicing of equipment which includes name, address and phone numbers for supplier and service contact for each piece of equipment.

.4 Include in this section a complete set of as-built drawings if not included elsewhere in this manual.

.5 Certification, guarantee, warranty.

.17 Software & Certificates

.1 Provide original copies of all software distribution media on CDs inserted into vinyl page holders that are designed for 3 ring binders. The originals are to be provided in “Set 1” of these O&M manuals and back-up copies are to be provided in “Set 2”.

.2 Provide software registration certificates, or other documents that verify authenticity of software.

.3 Provide back-up copies of entire system at the time of system turn over on CDs in vinyl CD page holders designed for 3 ring binders. Backup to include complete control sequence source code.

1.11 <u>Record Drawings</u>

.1 Before the certification of substantial performance will be issued the contractor must provide the Engineer with record drawings as follows:

.1 One electronic copy of record drawings in AutoCAD version 2000 or Visio format.

.2 Four (4) copies of as-built white prints in 280mmx432mm (8½” x 17”) capacity blue binders bound in heavy fabricated, hot stamped in white lettering front and spine. Each is to be identified As-Built Drawings and permanently numbered 1 to 4.

.3 The spine shall be lettered with the full identification title of the project and the front face shall be lettered with the following on the respective binders:

.1 Full identification title of the project

.2 Prime Consultant and Sub-Consultant - full identification

.3 Prime Contractor - full identification

.4 Mechanical Contractor - full identification

.4 Maintain an accurate record of all deviations and changes on a record drawing set of prints. Such record is to be maintained on a day-to-day basis.

.5 Maintain as-built data on the data gathering and automatic control equipment schedule and panel schedules.

2. Products

2.1 Approved Contractors

.1 Tenders on the following will be accepted:

.1 Siemens Building Systems – APOGEE product

.2 Johnson Controls – Metasys product

.3 ESC Automation – Delta Controls product

.4 Serv-All – Reliable Controls

.2 Alternates to these approved control system products can be submitted as a separate price from the base system specified.

2.2 General

.1 Provide control system components consisting of thermostats, control valves, dampers, actuators, indicating devices, and interface equipment required to operate mechanical equipment and perform functions specified.

.2 Provide all materials and labor required to connect control components.

2.3 BAS Architecture

.1 The BAS system shall be native BACnet, utilizing BACnet BTL approved modules and incorporating BACnet on all primary and secondary communication networks.

.2 The BAS shall be comprised of a network of interoperable, stand-alone digital controllers, operator work stations, server, graphical user interface software, network devices and other devices as specified herein.

.3 The BAS shall incorporate the ability to access all user interface functions as specified within these documents using standard internet browsers. Operator access to the BAS shall not require any proprietary operator interface or configuration software to be loaded on the respective PC and access shall only be limited by password.

.4 Provide for access to the BAS system by five (5) concurrent users, whether in the building or by Internet utilizing a standard web browser.

.5 The BAS system shall incorporate BACnet native devices and they shall be ANSI/ASHRAE 135-2012 BACnet BTL compliant. For components utilized on this project, they shall include the following capabilities:

.1 Enterprise Level Server – BACnet I/P with Web Server software

.2 Operator Workstation – BACnet I/P with Operator Workstation Software (B-OWS)

.3 Building Controllers – BACnet I/P with Building Controllers software (B-BC)

.4 Routers – BACnet I/P with Building Controllers software (B-BC)

.5 Advanced Application Controllers – BACnet I/P and/or MS/TP with Advanced Application software (B-AAC)

.6 Application Specific Controllers – BACnet MS/TP with Application Software (B-ASC)

.7 Third Party Devices – BACnet I/P and/or MS/TP with BACnet software

.6 The installed system shall provide secure multilevel password access to all features, functions and data contained in the overall BAS.

.7 Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner, at no cost, prior to project completion. Provide software on CDs and/or DVDs and licenses for:

.1 Database creation and editing

.2 Engineering of the system

.3 Service, Troubleshooting and/or Tool software

.4 Graphics generation

.5 Trending

.6 Historical trending to cover all hardware and software points

.7 Long term historical storage

.8 Mapping of database into the existing NAIT BAS network

.8 With the CDs and/or DVDs as noted above it shall not require the Owner to obtain any information, data, programs, etc. from the manufacturer and shall not require access over the internet to the manufacturer's site to perform the functionality. Provide 3 copies of the above CDs and/or DVDs.

.9 Downloading and Uploading

.1 Provide the capability to generate BAS software-based sequences, database items and associated operational definition information and user-required revisions to same, at any Operator PC, and the means to download same to the associated controller.

.2 Application software tool used for the generation of custom logic sequences shall be provided to the owner as part of this project.

.3 Provide the capability to upload BAS operating software information, database items, sequences and alarms to the designated server.

3. Execution

3.1 Electrical Work

.1 The BAS contractor shall supply and install all line and low voltage power and control wiring for the BAS system, including all 120/1/60 emergency power wiring to power the various BAS components. Refer to Section 23 09 13 for system requirements.

.2 For each 120/1/60 exhaust fan motor that is controlled from the BAS, the BAS contractor shall supply an electrical horsepower rated relay module, fully enclosed and turn over to the Electrical contractor for installation. The power wiring to the module and from the module to the motor shall be provided by the Electrical contractor, with the BAS contractor supplying and installing the control wiring to the BAS system.

.3 The BAS contractor shall supply and install all necessary 120/24 transformers and power supplies for the BAS equipment and shall supply and install all conduit, wire, fittings, boxes, etc. to extend the 24 volt AC/DC power to all the BAS equipment.

.4 Separate 120/24 volt transformers and/or power supplies shall be provided to **each** digital controller and transformers shall not be shared between digital controllers nor shall the transformers serving the digital controllers power the sensors, transducers, etc.

3.2 Air Handling Unit

.1 The unit providing ventilation air to the building shall be complete with integral controls to control the full functionality of the unit. The unit shall normally operate continuously.

.2 The unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.

.3 The BAS transducers for filter monitoring shall be mounted in the control panel of the AHU unit.

3.3 MUA Unit

.1 The unit providing make up air to the building shall be complete with integral controls to control the full functionality of the unit. The unit shall normally operate continuously.

.2 The unit shall provide external dedicated hardware connection points to the BAS for overall monitoring and enabling of the unit.

.3 The BAS transducers for filter monitoring shall be mounted in the control panel of the MUA unit.

3.4 Exhaust Fans

.1 Refer to the points list for exhaust fans that are controlled. Provide separate control and monitoring of fans for each typical application.

.2 For the garage exhaust fan the CO and NO2 sensors shall be utilized to control operation of the exhaust fan along with the intake motorized damper.

3.5 Split A/C Units

.1 The BAS contractor shall provide all control wiring between the roof mounted condenser and the indoor units. Note the usage of one roof mounted unit serving two indoor units; include for the necessary control wiring interconnections.

.2 The BAS room sensor shall provide for alarming within the room.

END OF SECTION

1. General

1.1 Scope

.1 Control Devices and Hardware

.1 Control Panels

.2 Wire

.3 Conduit and Cables

.4 Related Accessories

.5 Room Sensors

.6 Outdoor Air Sensors

.7 Duct Mount Sensors

.8 CO & NO_2 Sensors

2. Products

2.1 Control Panels

.1 Mount digital controllers in control panels with field interface equipment (i.e. relays, transducers, etc.) segregated in the panel and minimizing the electrical interference and heat to the digital controllers.

.2 The power supplies, transformers, contactors, etc. shall be mounted in separate ventilated metal enclosures.

.3 Control panels are to be of unitized cabinet type construction, fabricated from rolled sheet metal sheet with baked enamel finish, flush fitting, gasketed doors hung on piano type hinges and locking handles. All panels shall be CSA approved and equal to Hoffman enclosures and shall be common keyed.

.4 Mount gauges, pilot lights, push buttons and switches flush on cabinet panel face.

.5 Mount panels on vibration free walls or free standing angle iron supports. Provide engraved plastic nameplates for instruments and controls inside cabinet and on cabinet face.

.6 Provide pans and rails for mounting terminal blocks, relays, wiring and other necessary devices.

.7 Provide an individual switch for disconnection and a fuse for isolation of all panel mounted instruments requiring a 120 volt supply.

.8 Make all wiring connections in the shop from the equipment mounted on the panel to numbered terminal blocks conveniently located in the panel, including the power supply for all instruments.

.9 Identify all wiring by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring. Install all wiring neatly and laced or bunched into cable form using plastic wire clips, where practical, contained in plastic wiring channels with covers. Maximum 25 conductors to each wire bundle.

.10 Install bonding conductor between main control and auxiliary panels complete with grounding lugs, in addition to CSA grounding requirements.

.11 Provide terminal blocks, tabular clamp, 300 V, complete with track. Each terminal shall be clearly indelibly marked with the wire number connection to it. Each field connecting conductor shall be served by one terminal. Provide 20% spare unit terminals, with a minimum of two spare terminals. Provide all necessary terminal block accessories such as manufacturer jumpers and marking tape.

.12 Power for control panels shall be 120/1/60 15 amp circuits from power panel provided by Division 26.

2.2 Wire

.1 Control wiring for digital functions shall be 20 AWG minimum with 300 Volt insulation.

.2 Control wiring for analog functions shall be 20 AWG minimum with 300 Volts insulation, twisted and shielded, 2 or 3 wire to match analog function hardware.

.3 Sensor wiring shall be 22 AWG minimum twisted and shielded, 2 or 3 wire to match analog function hardware or 16 AWG as required by code.

2.3 Conduits and Cables

.1 All wiring, whether line voltage, low voltage or control wiring shall be in conduit or fully enclosed metal trays. Flexible conduit may be used for final connection of control devices. Maximum length of flexible conduit to be 1m (3 ft). Conform to Division 26 requirements for conduit, tray, fittings, junction boxes, cabinets, wire, cable and trays specifications.

.2 Exposed plenum rated cable shall not be utilized; all wiring shall be in conduit.

.3 Seal conduit where such conduit leaves heated areas and enters unheated area.

.4 In the field, run low level (<30 volts) signal lines in separate conduit from high level (>30 volts) signal and power transmission lines.

.5 In the field panel, run low level signal lines in separate conduit from high level signal and power transmission lines.

.6 Identify each cable and wire at every termination point by means of stamped markings on heat shrinkable tubing that is permanently fastened to wiring.

.7 Provide instrumentation complete with standard electrical conduit box for termination unless otherwise noted.

.8 Color code all conductors and conduits by permanently applied color bands. Color code shall follow base building schedule. Color code all conduit couplings orange, with orange banding on the conduits.

.9 All wiring for terminal equipment controllers including network communications, sensors and actuator wiring must be in conduit.

2.4 Related Accessories

.1 Provide and install all necessary transducers, interposing relays, interface devices, contactors, starters and EP's to perform control functions required.

.2 It is the responsibility of the BAS Contractor to identify, at the time of tender submission, all additional items not specified that are required to meet the operational intent specified.

2.5 Thermostats and Room Sensors

.1 Provide tamper proof guards for the following areas: entrances, public areas, corridors. Guards to be equal to BAPI-Guard.

.2 Safety low limit protection thermostats shall be manual reset type with 6m (18 ft) elements. Provide multiple thermostats for large duct cross-sectional areas. Mount thermostats on the outside of the ductwork and no higher than 1500mm (5 ft) above the floor. Provide DPDT contacts for connection to SCU or ASC.

2.6 Duct Mount Sensors

.1 Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.

.2 Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.

.3 For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.

2.7 Differential Pressure Transmitters

.1 General Air Pressure Transmitter Requirements:

  .1 Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.

.2 Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.

.2 Low Differential Air Pressure Applications (0” to 5” w.c.)

.1 The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.

.2 The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:

.1 (0.00 - 1.00” to 5.00”) w.c. input differential pressure ranges. (Select range appropriate for system application.)

.2 4-20 mA output.

.3 Maintain accuracy up to 20 to 1 ratio turndown.

.4 Reference Accuracy: +0.2% of full span

2.8 Status and Safety Switches

.1 General Requirements

.1 Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BAS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

.2 Current Sensing Switches

.1 The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.

.2 Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.

.3 Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

.4 Acceptable manufacturers: Veris Industries

2.9 CO & NO_2 Sensors

.1 General Requirements

.1 Sensors shall be provided to monitor the CO and NO2 levels in the garage.

.2 The sensors shall be connected to the BAS as separate analog inputs, providing either a 0-10V DC or 4-20 ma signal. Refer to the drawings for the location of the sensors.

.3 Sensors shall be Vulcain 301M series units; 0-250 ppm for CO and 0-10 ppm for NO_2.

3. Execution

3.1 Installation

.1 Verify location of sensors and other exposed control sensors with drawings before installation. Locate room temperature sensors 1500mm (5 ft) above floor. CO sensors shall be mounted 1-1.5 m above the floor; NO2 sensors shall be mounted 30 cm – 1m from ceiling.

.2 Wire "hand/off/auto" selector switches such that only automatic operating controls and not safety controls and electrical over current protection shall be overridden when switch is in the "hand" position.

.3 Unless specified otherwise, install all outdoor air sensors on the north exposure of the building.

.4 Install all safety limits at the operator’s level.

.5 Control System Power

.1 Provide power to all BAS components as necessary to provide continued monitoring and control.

.2 Power for all transducers and other instrumentation associated with a controller shall come from the same circuit that is feeding the digital controller.

.3 Identify in the record drawings the panel and circuit number serving each controller.

END OF SECTION

1. General

.1 This section is a module which specifies the Field Instrumentation, Sensing Devices and Actuators.

.2 For general requirements relating to all sections see Section 23 09 01.

2. Products

2.1 General

.1 Provide analog or digital field instrumentation devices as applicable which measure temperature, humidity, pressure, flow, current, voltage, equipment states, etc., and which input signals to the ASC and/or SCU terminal strip that conform to the input requirements.

.2 Provide output devices and actuators which convert the digital or analog output signal from the ASC and/or SCU to activate relays or open and close valves, dampers, etc.

.3 The end to end accuracy called for in Subsection 2.2 includes the combined effect of sensitivity, hysterisis, linearity and repeatability between the measured variable and the input to the analog-to-digital convertor in the ASC and/or SCU or between the ASC and/or SCU input to the digital-to-analog convertor and the controlled variable for the full sensing range.

.4 The letter under the "Type" column in Subsection 2.2 is the same used in the points list.

.5 Acceptable manufacturers of sensors are indicated in Section 3.0.

2.2 Analog Input Sensors

.1 Temperature

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct Mounted	Tp	0°C to 60°C (32°F to 140°F)	±0.5°C	
Pipe Well	Tw	0°C to 50°C (32°F to 122°F)	±0.5°C	c/w thermal wells
Mounted		0°C to 100°C (32°F to 212°F)	±0.5°C	
		50°C to 150°C (122°F to 300°F)	±0.5°C	
Averaging	Ta	-30°C to 60°C (-20°F to 140 °F)	±0.5°C	Length to suit duct side

Space Temp.	Tr	10°C to 301°C (50°F to 572°F)	±0.5°C	c/w tamper-proof cover
Outside Air	To	-50°C to 50°C (-58°F to 122°F)	±1.0°C	c/w solar-shield
Surface Temp	Ts	0°C to 50°C (32°F to 122°F)	±0.3°C	

.2 Relative Humidity

Acceptable Manufacturers: Hy-Cal, General Eastern

Application	Type	Operating Range	End to End Accuracy	Remarks
Duct mounted	Hp	5 - 90% RH 0°C to 60°C (32 °F to 140 °F)	±5%	
Space	Hr	5 - 90% RH	±5%	c/w tamper-proof cover
Outside air	Ho	5 - 100% RH	±5%	c/w solar-shield

.3 Pressure

Acceptable Manufacturers for Sp and Vp Sensors: Modus, Setra.

Application	Type	Operating Range	End to End Accuracy	Remarks
Static-water	Ps	0 to 104 kPa (0 to 15 psi)	±2%	
		0 to 208 kPa (0 to 30 psi)	±2%	
		0 to 689 kPa (0 to 100 psi)	±2%	
		0 to 2,000 kPa (0 to 300 psi)	±2%	
Static-air	Sp	0 to 500 Pa (0 to 2" WG)	±2%	
		0 to 1,250 Pa (0 to 5" WG)	±2%	
		0 to 2,500 Pa (0 to 10" WG)	±2%	
Instrument	Ia	0 to 150 kPa (0 to 20 psi)	±2%	
Velocity	Vp	0-62.5 Pa	±1.0%	-multi-point static &

pressure monitoring station – air		(0-0.25” WG) 0-125 Pa (0-0.5” WG) 0-250 Pa (0-1” WG)		total pressure sensing element manifold -self-averaging manifold -air equalizer & straightener -max. pressure loss 36 Pa @ 10 m/sec. -lowest sensitivity 1% of range
Flow monitoring station – water, steam	Pv	As required	±2.0%	-Paddle wheel
Fan Inlet- Air Flow Traverse Probes	Vpi	0-62.5 Pa (0-0.25” WG) 0-125 Pa (0-0.5” WG) 0-250 Pa (0-1” WG)	±3.0%	Multiple total and static pressure sensors connected to a self-averaging manifold. Provide steady non-pulsating signals of standard total and static pressure. Accuracy of ±3.0% of actual flow over a fan operating range of 6 to 1 capacity turn down.

.4 Electrical

Application	Type	Operating Range	End to End Accuracy	Remarks
Kilowatts	kW	Various voltages		From digital metering systems
Current transmitters	Ct	As required	±0.25% full scale	

2.3 Analog Output Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
To damper motors	De	0 - 10 VDC 4-20 MA	±2% full scale	
To valve actuators	Ve	0 - 10 VDC 4 - 20 MA	±1% full scale	

2.4 Digital Input Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
Pressure Switches	Pd	As required	±1.5% full scale	-adjustable setpoint and differential
Temperature	Td	As required	±1°C	-adjustable setpoint and differential -automatic reset -normal reset for freeze protection
Current Sensing Relays	Ri	As required	N/A	-adjustable trip c/w LED Status indication.
Motor status Relays	St	As required	N/A	-auxiliary contacts
Level	Ls	N/A	N/A	
Misc Inputs	Rc	N/A	N/A	Auxiliary contacts

2.5 Digital Output Devices

Application	Type	Operating Range	End to End Accuracy	Remarks
Relays	Ry	N/A	N/A	Plug-in type with terminal base contacts rated at 5 amp 120 VAC.

2.6 Signal Transmission

.1 Provide a digital transmission network to communicate between all SCU's as required.

.2 Digital transmission at 9600 baud minimum.

3. Execution

3.1 General

.1 Codes and Standards

.1 Install all components in accordance with the latest regulations of the Canadian Electrical Code, applicable Municipal and Provincial Codes and Regulations, latest CSA Electrical Bulletins and Division 26.

.2 The paddle wheel water and glycol flow transmitters shall be ONICON F-1210 dual paddle assemblies, with an analog 0-10V DC output.

.3 Where water or glycol differential pressure transmitters are indicated, differential pressure transmitters shall by supplied and not separate pressure transmitters with a calculation in software. The differential pressure transmitters shall be equal to SETRA DPT 230 series with a 5 valve manifold and provide a 0-10V DC and/or 4-20 ma signal. Provide a single pressure, nominal 100 mm gauge piped to the extra 2 valves to allow for local indication. Unit assembly to be mounted on the nearest wall, nominally at 2 meters above the floor.

.4 Water or glycol pressure transmitters shall be equal to SETRA DPT 209 series transmitters, c/w snubber, hand valve and 100 mm pressure gauge to provide a 0-10V Dc and/or 4-20 ma signal. Units to be mounted on the nearest accessible wall location, at the same nominal height as the piping connection.

.5 Current relay modules shall be SENTRY series 100/200 series to provide a 4-20ma or 0-10VDC signal according to the motor current, with frequency variations from 10 to 400 Hz.

.6 Current sensing relays shall be Greystone series CS-610-75 with LED and range adjustment and provide a dry contact signal.

.7 Air pressure switches shall be mounted in the BAS panel, with the tubing extended out to the unit. Switches to be Cleveland Controls AFS-460 series with manual reset.

.8 Carbon Monoxide (CO) and Nitrogen Dioxide (NO2) sensors shall be as noted in Section 23 09 13 – Instrumentation and Control Devices for HVAC.

.9 Strap on temperature sensors used on small piping, where wells are too large, shall be equal to Enercorp TS-BP series c/w armor leads. The units shall be securely attached to the surface of the pipe, with covering insulation.

.10 Static and differential air pressure transmitters shall be Dwyer DM-2000 series, complete with digital display and an analog signal for connection to the BMCS. The units shall be mounted in the BMCS panels and shall be complete with capped connections to allow for a local meter to calibrate and check the units.

.11 Static and differential air pressure transmitters out in the spaces shall be Dwyer DPT 264 series, 0.5% accuracy with a 0-10V DC and/or 4-20 ma signal for connection to the BMCS.

.12 For each static and/or differential air flow transmitter, air pressure switch, etc. connection into the ductwork provide a standard production Dwyer series 160 pitot tube, with duct clamp and gasket for sensing the total and/or static pressure. For static pressure measurements extend the second reference line connection from the panel to a point outside and adjacent to the pitot tube. Leave the line open and tag it indicating the line is to be kept open. Provide capped fittings at the pitot tube for connection of a remote gauge.

.13 For all the various transducers, supply and install the required transformers, power supplies, fusing, filters, etc. as required to provide the reduced voltage to the devices.

END OF SECTION

1. General

.1 The control sequences below provide a general description of the intent of the operation of the systems to be controlled. The BAS Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 Consult with the Engineer during the shop drawing stage to finalize the control sequences for each system

.3 The BAS Contractor shall ensure that all end devices and sensors are on

.4 On loss of building power and building power being restored, all equipment, including that on emergency power, shall be reset to nominal start up conditions and shall run through its normal start up sequence prior to returning to required operating conditions. The BAS Contractor shall ensure that all end devices and sensors are on emergency power, if available, as required, to accommodate system operation under normal and emergency conditions.

1.2 Systems

.1 Air Handling Unit

.2 Make-Up Air Unit

.3 Exhaust Fans

.4 Garage CO & NO2 Monitoring

.5 ACU Unit Monitoring

2. Products

Not Applicable

3. Execution

3.1 General

.1 Provide data base for all hardware points listed for system operation to meet specification operating sequences.

3.2 Air Handling Units

.1 Air handling unit RTU-1 is an outdoor, constant, mixed air system serving the administration area. The system consists of one (1) supply fan (complete with VFD), a mixing section with outside air, return air and exhaust air dampers, filter section with pre-filters and final filters, DX cooling coil, indirect gas-fired heating section.

.2 The air handling units shall be controlled by controls integral in the unit, with provision for connection to the BAS with dedicated hardware I/O points for monitoring and reset of supply air temperature.

.3 System Start/Stop

.1 The air system will be energized via the BAS and operate continuously. The system may operate in a timed program mode according to the owner prescribed time schedule. The time schedule sequence shall include optimum start and stop control sequences once the operation schedule is determined.

.2 Upon a signal from the Fire Alarm system, the air system shall be de-energized; the connection to the Fire Alarm system shall be hardwired by the Electrical contractor.

.3 The exhaust fan #5 shall be controlled by the BAS and software interlocked when either or both AHU units are operational.

.4 Minimum Outdoor Damper Position

.1 The minimum outdoor damper position will be set in the AHU unit.

.5 Temperature Control

.1 The mixed air dampers, DX cooling coil and heat section shall be modulated in sequence to maintain a supply air temperature setpoint of 12.8°C (55°F) (adjustable). The supply air temperature setpoint shall be able to be reset from the BAS.

.2 Space sensor(s) shall be utilized in the BAS software to optimize the supply air setpoint to meet acceptable space conditions.

.6 Air Flow Monitoring

.1 The supply fan is constant volume. The operation is controlled and monitored by the BMS.

.7 Purge Mode

.1 All air handling units will be placed on a building purge mode for 30 to 60 minutes (adjustable) at a preselected time before building occupancy, where time programming is utilized.

.2 During purge mode:

.1 Set mix air set point at 5°C (42°F)

.2 Set supply air temperature setpoint at 18°C (65°F)

.3 De-energize cooling coil

.4 Energize all washroom and general exhaust fans

3.3 Make-Up Air Unit

.1 Make-up air unit MUA-1 is an outdoor, constant volume, 100% outside air system serving the cell block area. The unit consists of an outside air intake, filter section, one (1) supply air fan complete with VFD, DX cooling coil and an indirect gas-fired heat exchanger.

.2 System Start/Stop

.1 The Make Up Air system will be energized via the BAS and operate continuously.

.2 Upon a signal from the Fire Alarm system, the Make Up Air system shall be de-energized; the connection to the Fire Alarm system shall be hardwired by the Electrical contractor.

.3 The exhaust fans #1, #2, #3 shall be controlled by the BAS and software interlocked when either or both Make Up Air units are operational.

.3 Temperature Control

.1 The make-up air units shall be controlled by their own integral controls and shall modulate the gas valve to maintain a supply air temperature setpoint. The supply air temperature setpoints shall be provided by the BAS.

.2 Space sensor(s) shall be utilized in the BAS software to optimize the supply air setpoint to meet acceptable space conditions.

3.4 Exhaust Fans

.1 Exhaust fans EF-1 and EF-5 shall be software interlocked with rooftop unit RTU-1 and shall operate if the rooftop unit is operating.

.2 Exhaust fan EF-2 shall be software interlocked with make-up air unit MUA-1 and shall operate if the make-up air unit is operating.

.3 Exhaust fans EF-1 and EF-2 shall be interlocked with motorized dampers.

3.5 Stand Alone Air Conditioning Units

.1 A low voltage space temperature sensor/controller, provided with the unit, shall control each air conditioning unit to maintain a room setpoint temperature of 23.9°C (75°F) (adjustable).

.2 The BAS shall monitor the space temperature served by the Air Conditioning Unit.

3.6 Domestic Hot Water System

.1 The domestic hot water system consists of one (1) gas-fired domestic water heater (DWH-1) and one (1) domestic hot water recirculation pump (P-1).

.2 The domestic hot water tank's temperature is to be maintained at a 60°C (140°F) (adjustable) setpoint by the manufacturer supplied, pre-wired controls.

3.7 Electric Heaters

.1 Electric cabinet unit heaters and baseboard heaters shall be controlled by an integral thermostat. The thermostat shall initially be set for 21°C (70°F). There shall be no connection to the BAS.

3.8 Garage Bay and Secure Bay Ventilation Systems

.1 The Garage Bay and Secure Bay ventilations system consists of an exhaust fan with motorized dampers and intake motorized dampers. The exhaust fan is interlocked with the motorized dampers.

.2 Carbon monoxide and Nitrogen Dioxide levels are monitored throughout via sensors. The CO and NO2 levels from the sensors are fed to the BAS. If an alarm threshold is indicated the following shall occur.

.1 The outside air motorized damper shall open and shall be proven open via an end switch in the actuator.

.2 The exhaust air damper shall open and shall be proven open via an end switch in the actuator. The exhaust fan shall be energized and operation shall be proven via a current relay on the exhaust fan.

.3 The exhaust fan shall operate for at least 15 minutes (adjustable) after which time exhaust fan shall de-energized and motorized dampers shall close.

3.9 Domestic Water Booster Package

.1 The system shall start upon a drop in system pressure, and will regulate the speed of the pumps to maintain constant pressure under variable flow.

.2 The system will stop upon detection of no-flow.

.3 The BAS shall monitor the pump package for operation and alarms.

3.10 Gas Fired Unit Heaters

.1 A line voltage electric thermostat shall cycle the unit motor. The thermostat shall have a 15°C (59°F) setpoint (adjustable).

3.11 Electric Heat Trace

.1 The BAS shall energize the heat tracing when the ambient air temperature is below 5°C (41°F) (adjustable). The heat tracing shall be de-energized when the ambient air temperature is 5°C (41°F) (adjustable) or above.

3.12 Master Outside Air Temperature Sensor

.1 An outside air temperature (OAT) calculated value will be used for all control references. This calculated value will be determined using two (2) outdoor air temperature sensors, one located on the north and south face of the building. Any individual OAT sensor that is determined to be in error will not be used in determination of the calculated value. An OAT sensor error alarm shall be tied into the BAS system.

END OF SECTION

System **Make Up Air Units**

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
MUA Unit									
Supply Fan Status	Ri	XS		X	X				
Unit Start/Stop	Ry	JZ	X						
Cooling Status	Ri	XS		X					
Cooling Enable	Ry	JZ	X						
Heating Enable	Ry	JZ	X						
Outside Air Temp	To	TT					X		
Supply Air Temp	Tp	TT					X	XX	
Space Temperature	Tr	TT					X	XX	**2 - Exterior; 1-Interior**
Supply Air Temp Setpoint	Zt	ZT				X			
Common Alarm	Rc	XS		X	X				
Filter Monitor	Pt	DPT					X	XX	
Exhaust Fans									**1 Req'd / EF #1**
Status	Ri	XS		X	X				
Start/Stop	Ry	JZ	X						
Exhaust Air Temp	Tp	TT					X	XX	

System **AHU Units**

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Supply Fan									
Status	Ri	XS		X	X				
Start/Stop	Ry	JZ	X						
Cooling Status	Ri	XS		X					
Cooling Enable	Ry	JZ	X						
Heating Enable	Ry	JZ	X						
Outside Air Temp	To	TT					X		
Supply Air Temp	Tp	TT					X	XX	
Space Temperature	Tr	TT					X	XX	**3 - Exterior; 1-Interior**
Supply Air Temp Setpoint	Zt	ZT				X			
Filter Monitoring	Pt	DPT					X	XX	
Exhaust Fan									**2 Req'd / EF #1, EF #5**
Status	Ri	XS		X	X				
Start/Stop	Ry	JZ	X						
Exhaust Air Temp	Tp	TT					X	XX	

System **Miscellaneous**

POINT DESCRIPTION	*POINT TYPE	POINT TAG (DIAGRAMS)	DIGITAL			ANALOG			REMARKS
			OUTPUT	INPUT	ALARM	OUTPUT	INPUT	ALARM LIMITS	
Garage									
EF Status	Ri	XS		X	X				
EF Start/Stop	Ry	JZ	X						
CO Sensor	CO	COT					X	XX	
NO2 Sensor	NO2	NOT					X	XX	
ACU Units									**Typical for Each Unit**
Space Temp	Tr	TT					X	XX	
Domestic Booster Package									
Pump Status	Ri	XS		X	X				
Alarm	Rc			X	X				
Heat Trace									
Rain Water Heat Tracing	Ry		X						5 Locations - Coordinate with drawings

1. General

1.1 Quality Assurance

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Comply with CSA B149.1 for natural gas systems.

.5 All steel piping below grade shall be yellow jacketed.

1.2 Quality Assurance – Welding

.1 For complete welding requirements refer to Section 23 05 00 – Common Work Results for HVAC.

1.3 Reference Standards

.1 American Society of Mechanical Engineers (ASME)

.1	ASME B16.5	Pipe Flanges and Flanged Fittings.
.2	ASME B16.18	Cast Copper Alloy Solder Joint Pressure Fittings.
.3	ASME B16.22	Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
.4	ASME B18.2.1	Square and Hex Bolts and Screws.

.2 American Society for Testing and Materials (ASTM)

.1	ASTM A47/A47M	Specification for Ferritic Malleable Iron Castings
.2	ASTM A53/A53M	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
.3	ASTM B32	Specification for Solder Metal
.4	ASTM B75M	Specification for Seamless Copper Tube [Metric]

.3 Canadian Standards Association (CSA)

.1 CSA W47.1 — Certification of Companies for Fusion Welding of Steel Structures

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

.1 CAN/CGA B149.1 — Natural Gas Installation Code

1.4 Related Work Specified in Other Sections

.1 Common Work Results for HVAC — Section 23 05 00

.2 General Duty Valves for HVAC Piping — Section 23 05 23

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Acceptable manufacturers

1. Pipe and Fittings : Crane, Grinnell, Ladish, Taylor Forge
2. Plastic Pipe and Fittings : Building Products Orion, Emco, Domm-X,Scepter, Canplas

2.2 Pipe and Fittings

Size	Material	Fittings	Joint
1. Above Grade (Accessible Joints):			
50 (2”) and under	ASTM A-53, Schedule 40, continuous ERW or seamless	ANSI B16.3 MI, 1034 kPa rated	Threaded
65 (2½”) and over	ASTM A-53, Schedule 40, continuous ERW or seamless	ASTM A-234 standard weight wrought welded	Welded
2. Above Grade (Inaccessible Joints):			

Size	Material	Fittings	Joint
All sizes	ASTM A-53, Schedule 40 continuous ERW or seamless	ASTM A-234 standard weight wrought welded	Welded
3. Below Grade:			
All sizes	CSA B137.4 polyethylene for gas service with tracer wire	As approved by authority having jurisdiction	As approved by authority having jurisdiction

2.3 Unions and Flanges

.1 Size 50mm (2”) and under: 1035kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping. Unions to ANSI B16.3.

.2 Sizes 65mm (2½”) and over: 1035 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1035 kPa (150 psi) bronze slip-on flanges for copper piping. 1.6mm (0.06”) thick preformed synthetic rubber, compressed ARAMID/NBR (Durlon 8500). Gaskets to be rated for temperature and pressure of system. Flanges to ASTM A181, Grade 1. For 517 kPaG and higher, use Class 300. For all others, use Class 150.

3. Execution

3.1 Piping General

.1 Install piping approximately as shown, with all lines being carried parallel to building walls, close to the structure as possible, or as detailed on the drawings.

.2 Align and support all piping properly, under no circumstances may any piping load be transferred to the equipment. Make all equipment connections so as to allow disassembly of the piping for equipment removal and maintenance.

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

.4 Provide clearance for proper access to valves, vents and unions.

.5 Install piping material specified to 1.0m (3 ft) outside of building or as noted on drawings.

.6 Use the following for branch connections off of main:

.1 Mains 100mm to 200mm (4” to 8”) inclusive: branches under 40mm (1½), use factory manufactured welding fittings to accommodate the take-off either welded or threaded; branches 50mm to 75mm (2” to 3”), use welding saddles; branches 100mm and over, use standard tee. Do not use welding saddles for branches greater than size of main.

.2 Mains 75mm (3”): branches under 25mm (1”), use factory manufactured welding fittings to accommodate the take-off welded or threaded; branches over 25mm, use standard tees.

.3 Mains 65mm (2½”) and under: use standard tees for all branch take-offs.

.4 Mains 250mm (10”) and over: branches up to and including 2 nominal sizes less than main, welded stub-ins, tee or saddles. Branches nominal size smaller and above, use standard tees.

.7 Do not use direct welded or screwed connections to valves, equipment or other apparatus. Make all connections with an accessible mechanical connection of a style consistent with the connecting pipe joints.

.8 Sleeve all pipe passing through partitions, walls and floors.

.9 Provide non-conducting type dielectric connections wherever jointing dissimilar metals.

.10 Ensure no contact between copper and ferrous metal.

.11 Keep open ends of pipe free from scale and dirt. Whenever work is suspended during construction, protect the open ends by using temporary plugs, burlap or other means approved by the consultant.

.12 Provide for isolation of systems by section.

.13 Protect all steel pipes when stored on site from external conditions and ensure protective coating remains intact. If in the opinion of the engineer, deterioration of the protective coating has instigated corrosion, all rust must be removed down to bare metal and prime coated with red oxide paint.

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

.15 Yellow jacket all buried steel lines. Test all buried lines prior to backfill with holiday detector, "JEEPING". All lines exposed to outdoors (unless insulated and clad) to be painted. Repair any damaged covering.

.16 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

3.2 Screwed Connections

.1 American National Taper pipe thread must be used for all screwed connections. Remove burrs and chips and ream or file the pipe ends out to size or bore. Not more than two (2) imperfect threads exposed when joint make-up.

.2 Make screw joints metal to metal. Do not use lampwick or other packing material in making up screwed joints.

.3 Use Teflon tape, red lead and linseed oil or other approved non-toxic joint compound applied to male threads only.

.4 Thread chromium plated piping and make up carefully. Do not expose more than one full turn of thread beyond any fitting.

3.3 Welded Connections

.1 Prepare mating surfaces properly, at least one mating surface shall be beveled. Longitudinally align piping carefully, set 3.2mm (⅛") space between mating surfaces and tack, using 6010 rod. Preheat the materials to be joined to at least 21°C (70°F). Make a minimum of three (3) passes; use 6010 rod for root pass, use 7018 rod for subsequent filler passes and final cover pass. Remove slag and flux after each pass by brushing or grinding. Remove voids from each pass by cutting or grinding and make good by back welding.

.2 Ensure complete penetration by the root pass. Measured at the inner diameter of the piping, the weld shall be a minimum of 1mm thicker than the pipe thickness.

.3 Do not caulk or pean welds.

3.4 Gas Distribution Lines Installation

.1 Install the gas distribution lines in accordance with the policy and specifications of the Gas Utility and Provincial Inspection Authorities.

.2 Weld all natural gas piping in concealed inaccessible spaces regardless of size.

.3 Paint all natural gas piping throughout with high visibility yellow paint, except where concealed where stripes are permitted. Refer to Section 23 05 53 – Painting and Identification for HVAC.

3.5 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 furring to a minimum.

END OF SECTION

1. General

1.1 Quality Assurance

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

1.2 Reference Standards

.1 American Society of Mechanical Engineers (ASME)

.1	ASME B16.22	Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings
.2	ASME B16.24	Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500
.3	ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
.4	ASME B31.5	Refrigeration Piping

.2 American Society for Testing and Materials (ASTM)

.1	ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
.2	ASTM B280	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

.3 Canadian Standards Association (CSA)

.1	CSA B52	Mechanical Refrigeration Code

.4 Environment Canada (EC)

.1	EPS 1/RA/1	Environmental Code of Practice for the Reduction of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.4 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Pipe & Fittings

Size	Material	Fittings	Joint
.1 All Sizes	ASTM B88 Type L, ACR Copper hard temper	ANSI B16.22 Wrought copper	Brazed, phos copper alloy
.2 All Sizes	ASTM B88 Type L, ACR Copper hard temper	Forged Brass	Brazed, silver alloy

3. Execution

3.1 Preparation

.1 Remove burrs and chips and ream or file the pipe ends out to size or bore. Clean off scale and dirt, inside and outside, before assembly. In the case of soft copper tubing, ensure that reaming restores tubing to full diameter before jointing to fitting.

.2 Assemble joints without binding. Brazing material or solder shall penetrate fully and fill the joint completely.

3.2 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.

3.3 Connection

.1 Make connections to equipment, specialty components, and branch mains after isolation valves, with unions or flanges.

.2 Flexible Connections: 10mm or less to be made by coiled soft copper tubing. For larger sizes, use seamless flexible bronze hose with bronze wire braid covering. Use factory sealed neoprene jacket unit where freezing may occur.

3.4 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 furring to a minimum.

3.5 Installation

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

.2 Provide clearance for proper installation of insulation.

.3 Elbows and fittings to be kept to a minimum.

.4 Ensure refrigerant piping is arranged to return oil to the compressor. Pitch all horizontal lines a minimum of 1:250 in the direction of refrigerant flow.

.5 Provide traps in the piping systems as required and keep horizontal dimensions of traps as small as possible. Use double risers as required to obtain proper velocity in vertical risers.

.6 Any suction riser 9m (29.5 ft) or more in length to have trap every 4.5m (14.8 ft) of vertical rise.

.7 Branch suction lines to be connected from top of suction main using wye-fitting. Ancillaries and accessories such as back-pressure compensating regulators and back regulators to be installed horizontal.

.8 Do not obstruct view of oil level bulls-eye or run piping so that it interferes with services to compressor.

.9 Copper tubing exposed to mechanical injury to be enclosed in rigid or flexible conduit.

.10 Pipe sleeves to be hard copper or steel, sized to provide 6mm clearance between sleeve and uninsulated pipe or between sleeve and insulation.

.11 Joints: Piping to be kept sealed except when fabricating.

.1 Limit breakable joints to equipment connections and connections not normally braced. Flared joints limited to 10mm O.D. for field assembly, 16mm (⅝”) O.D. for factory assembly.

Standard of Acceptance: Madden, Watsco, Superior.

.2 Bleed dry nitrogen into piping when sweating connections.

3.6 Dehydration and Charging

.1 Close service valves on factory charged equipment.

.2 Ambient temperatures to be at least 13°C (55°F) 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 5 Pa (0.02" WC) 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 (0.06" WC) absolute and hold for 4 hours.

  .2 Break vacuum with refrigerant to 14 kPa (2 psi).

  .3 Final to 5 Pa (0.02" WC) 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 Engineer.

.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 to Engineer.

END OF SECTION

1. General

1.1 Scope

.1 Liquid indicators

.2 Strainers

.3 Hot Gas Regulator and hot gas piping, for last stage, piped between coil and condensing unit

.4 Filter-driers

.5 Solenoid valves

.6 Expansion valves

.7 Refrigerant charging valves

1.2 Quality Assurance

.1 Use highest quality piping confirming to the appropriate ASTM and CSA specifications.

.2 Use tradesmen licensed by the provincial authorities for the particular service.

.3 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.4 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

1.3 Reference Standards

.1 American Society of Mechanical Engineers (ASME)

.1	ASME B16.22	Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings
.2	ASME B16.24	Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 400, 600, 900, 1500 and 2500
.3	ASME B16.26	Cast Copper Alloy Fittings for Flared Copper Tubes
.4	ASME B31.5	Refrigeration Piping

.2 American Society for Testing and Materials (ASTM)

.1	ASTM A307	Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength

.2 ASTM B280 — Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service

.3 Canadian Standards Association (CSA)

.1 CSA B52 — Mechanical Refrigeration Code

.4 Environment Canada (EC)

.1 EPS 1/RA/1 — Environmental Code of Practice for the Reduction of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.4 <u>Delivery & Storage</u>

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.5 <u>Waste Management and Disposal</u>

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 <u>Submittals</u>

.1 Provide shop drawings and schedules for review. Include all product information, materials of construction capacities and performance data.

2. Products

2.1 <u>Liquid Indicators</u>

.1 Liquid indicators shall be double port type with copper brass body, and flared or solder ends.

.2 Provide removable seal caps on each port to inspect refrigerant condition.

2.2 <u>Strainers</u>

.1 Refrigerant strainers shall be angle replaceable cartridge type with brass shell.

.2 Cartridge material and screen size shall be suitable for refrigerant and piping materials utilized in the system.

2.3 <u>Hot Gas Regulator</u>

.1 Sweat end, screw adjustment, integral electric shut off valve, or a separate electric solenoid shut-off valve upstream of hot gas regulator.

2.4 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.

2.5 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.

2.6 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 superheat setting and be complete with capillary tube and remote sensing bulb.

2.7 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.

2.8 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 230mm (9”) long and provided with bronze fittings to facilitate connection to equipment.

3. Execution

3.1 Liquid Indicators

.1 Provide full size liquid indicators in main liquid line leaving condenser. If a receiver is used, install in liquid line leaving receiver.

3.2 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 Provide shut-off valve at each side of strainer to facilitate maintenance.

3.3 Refrigerant Driers

.1 Provide full flow permanent refrigerant drier in low temperature systems and systems utilizing hermetic compressors.

.2 Mount drier vertically in liquid line adjacent to receiver with three valve bypass assembly to permit isolation of drier for servicing.

3.4 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.

3.5 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 operable stems.

3.6 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 6°C of superheat.

.4 Locate remote expansion valve sensing bulb immediately after evaporator outlet on suction line.

3.7 Charging Valves

.1 Provide refrigerant charging connections in liquid line between receiver shut-off valve and expansion valve.

3.8 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.

END OF SECTION

1. General

1.1 Scope

.1 Ductwork and plenums

.2 Fasteners

.3 Sealants

1.2 Quality Assurance

.1 Use highest quality materials conforming to the appropriate ASTM and ANSI specifications.

.2 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities in the area of jurisdiction.

.3 Be guided by "A Manual of Recommended Practice for Industrial Ventilation" issued by the American Conference of Governmental Industrial Hygienists.

.4 Ductwork shall meet the requirements of NFPA No. 90A - Air Conditioning and Ventilating Systems.

.5 Fabricate in accordance with SMACNA duct manuals and ASHRAE handbooks as a minimum where more stringent requirements are not identified in the contract documents. Straight tap fittings and dovetail joints are not permitted. Comply with SMACNA Duct Construction Standards for duct pressure rating including requirements for cross breaking, reinforcement, longitudinal seams, transverse joints and sealing. Confirm pressure ratings with consultant prior to fabrication.

.6 Ductwork used on this project shall be clean and free from scale, corrosion and deposits. All ductwork shall be degreased and wiped clean of all oil and other surface films with appropriate solvents prior to installation.

.7 All ductwork shall be delivered clean to the site and maintained in clean condition. Dirty ductwork shall be removed from site.

.8 Test the ductwork installation.

1.3 Definitions

.1 Low Pressure: Static pressure in duct less than 500 Pa (2" WG) and velocities less than 10 m/s (2000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1500 Pa (6" WG) and velocities greater than 10 m/s (2000 fpm).

1.4 Product Options

.1 Size round ducts installed in place of rectangular ducts indicated from ASHRAE table of equivalent round and rectangular ducts. No variation of duct configuration or sizes permitted except by written permission of the consultant. Extent of options will be limited for example; round duct will not be permitted on ducts downstream of terminal units except where shown.

.2 Use of a pre-manufactured bolted transverse duct joint/seal connection is permitted on ductwork constructed of material between 1.2mm and 0.8mm inclusive.

1.5 Reference Documents

.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 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

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

.3 National Fire Protection Association (NFPA)

.1 NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems

.4 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible

.2 SMACNA HVAC Air Duct Leakage Test Manual

.3 IAQ Guideline for Occupied Buildings Under Construction

.5 National Research Council (NRC)/Institute for Research in Construction

.1 National Energy Code of Canada for Buildings (NECB) 2011

1.6 Related Work Specified in Other Sections

.1 HVAC Air Distribution System Cleaning Section 23 01 30.51

.2 Common Work Results for HVAC Section 23 05 00

.3	Documentation for HVAC Systems	Section 23 05 05
.4	Supports and Anchors for HVAC Piping and Equipment	Section 23 05 29
.5	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.6	Vibration and Seismic Controls for HVAC	Section 23 05 48
.7	HVAC Insulation	Section 23 07 10
.8	Air Duct Accessories	Section 23 33 00
.9	Air Outlets and Inlets	Section 23 37 00

1.7 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

2. Products

2.1 Materials

.1 Make round, oval and rectangular ductwork unless specifically noted otherwise of lock-form quality galvanized steel, ASTM designation A93-59T, with copper bearing base metal having 0.20% copper added and 380 g/m² class zinc coating to ASTM A525-M87. Galvanizing quality must allow sheets to be bent flat upon themselves with no fracture to the coating or base metal.

.2 Flexible Duct Liner: line with specified thickness of black matte faced insulation, Manson Akousti-Liner. N.R.C. for 25mm material: minimum of 0.75 absolute roughness not greater than 0.0008 feet, substrate must not be dark in colour. Seal edges and joints with an approved fire resistant mastic. Protect leading and trailing edges with sheet metal edging.

.3 Rigid Duct Liner: Manson Akousti-Liner-R, N.R.C. for 25mm material of 0.80. Rigid liner to be used in plenums and/or where maximum air velocities do not exceed 24.5 m/sec.

.4 Duct Liner Protection, High Velocity: perforated galvanized steel meeting ASTM A-527-67. Minimum thickness, ducts, 0.70mm thick to 1200mm duct diameter, 1.0mm over 1200mm fittings 1.0mm thick all sizes.

.5 Fasteners: Use rivets and bolts throughout, sheet metal screws accepted on low pressure ducts. Fasteners to be corrosion resistant. Kitchen exhaust ducts to be welded.

.6 Sealants: water based, fire resistive, compatible with mating materials, ULC labeled, MP multi-purpose high velocity sealant.

.7 Strap Hangers: galvanized steel as ductwork but one (1) gauge heavier.

.8 Hangers: black steel threaded rod.

.9 Traverse Supports and Reinforcing: galvanized steel as ductwork or mild steel sections.

.10 Use aluminum ducts for swimming pool ventilation or handling moisture laden air.

2.2 Ductwork Pressures

.1 Provide ductwork and plenums fabricated from galvanized steel for the static pressure categories listed below.

.1 1000 Pa (4" W.G.) static pressure:

.1 All supply air ductwork downstream from supply air handling units discharge, to the upstream side of mixing boxes/air valves.

.2 All exhaust and return air ductwork downstream from return/exhaust air valves to the return/exhaust fans and downstream from the return/exhaust fans to the air handling units and/or outdoor relief.

.2 500 Pa (2" W.G.) static pressure

.1 All supply ductwork downstream from mixing boxes/air valves to terminal air outlets.

.2 All supply ductwork on systems without mixing boxes/air valves.

.3 All return air ductwork and plenums, except where otherwise specified.

.4 All exhaust and relief air ductwork and plenums, except where otherwise specified (welding/sawdust exhaust).

.5 All outdoor air ductwork, except as otherwise specified.

2.3 Fabrication – Ductwork

.1 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18”) 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 1½ times width of duct on centre line.

.4 Increase duct sizes gradually not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

.5 Rigidly construct metal ducts with joints mechanically tight, substantially air-tight, braced and stiffened so as not to breathe, 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 (2) ducts maintaining original duct area.

2.4 Lined Ductwork

.1 Comply with SMACNA "Duct Liner Application Standard".

.2 Unless otherwise indicated, maintain the net free area of the duct dimensions given on the drawings. Increase metal duct dimensions as necessary to compensate for the addition of the liner.

.3 Unless otherwise indicated, lining thickness is 25mm (1").

.4 Where round ductwork is indicated to be acoustically insulated, it shall consist of two concentric round ducts with 25 mm (1") thick flexible fibrous glass duct liner between the two ducts. The inner duct shall be perforated and correspond to the duct diameter noted on the drawings. The outer duct shall be suitable for the static pressure and shall be sealed airtight where it joins the adjacent ductwork.

.5 Provide duct lining where indicated on drawings.

2.5 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, shall be sealed using,

.1 Low Pressure Ductwork:

.1 Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5mm (16 gauge) use heavy mastic type sealant.

.2 Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.

.3 Other Joints: Heavy mastic type sealant.

.2 Medium and High Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 All ducts to be sealed to SMACNA Sealing Class A.

.3 Duct tapes as sealing method are not permitted.

.4 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.5 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the engineer.

.6 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

2.6 Turning Vanes

.1 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 0.76mm (22 ga). Vanes shall be spaced at 40mm (1-1/2") centers and shall turn through 90 deg., with a radius of 50mm (2"). Vanes shall not include a straight trailing edge. Refer to Figs. 2-3 and 2-4 of the SMACNA Duct Standards. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 0.86mm thick (18 ga).

.2 For 500 Pa (2" WC) pressure systems, install tie rods to limit the maximum unsupported vane length to 914mm (36"). Refer to Fig. 2-4 of the SMACNA Duct Standards.

.3 For 750 Pa (3" WC) and greater pressure systems, install tie rods to limit the maximum unsupported vane length to 460 mm (18"). Refer to 2-4 of the SMACNA Duct Standards.

.4 When turning vanes are located in acoustically insulated ductwork, provide turning vanes of perforated metal type with fiberglass inside.

3. Execution

3.1 General

.1 The project drawings are diagrammatic and although efforts have been made to provide information regarding the number of offsets and transitions, not all are necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. All required adjustments shall be established when coordinating and field measuring the work prior to fabrication and must be provided as part of the contract and all associated costs must be considered and included.

.2 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

.3 Prior to the fabrication of ductwork, co-ordinate and field measure all ductwork to ensure a complete installation respecting all other services. Fabricate ductwork from field measurements and not from plans and shop drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.4 Provide all necessary fittings, offsets, and alternate construction methods to facilitate the installation.

.5 Proper sized openings shall be arranged for in the correct locations through all slabs and walls. Openings shall be planned to include for the installation of fire dampers at all rated fire separations.

.6 Where ducts penetrate roofs, install sleeves and roof curb c/w flashing and counterflashing. Pack sleeves in roof with fibreglass insulation.

.7 During construction, protect openings in ductwork, from dust infiltration, by covering with polyethylene, and protect floor outlet duct openings with metal caps. Clean any ductwork found to be dirty at no extra cost to the Contract.

.8 Where ductwork is required to pass through open web steel joists, coordinate with the joist fabricator before fabricating ductwork.

.9 Where a duct contains a fire or smoke damper, construct the duct so that the free area of the duct is maintained through the fire or smoke damper.

.10 Where a duct is to be internally insulated, enlarge the duct so as not to reduce the duct free area.

3.2 Installation

.1 Make the taper of diverging transitions less than 20 deg. and the taper of converging transitions less than 30 deg., in accordance with Fig. 2-9 of the SMACNA Duct Standards. Maximum divergence upstream of equipment to be 30 deg. and 45 deg. convergence downstream.

.2 Make the inside radius of any rectangular duct elbow at least equal to the duct width, measured in the direction of the radius. If space conditions do not permit a full radius elbow to be installed, use square elbows with multi-blade turning vanes.

.3 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs as required to suit site conditions and maximize acoustic performance of the ductwork.

.4 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with Fig. 2-16 of the SMACNA Duct Standards. Adjustment shall be accessible outside the duct with lockable quadrant operator or through the grille or register with key-operated worm gear mechanism.

.5 Cross-break or bead all metal duct panels unless otherwise noted.

.6 Do not cross-break duct panels on 750 Pa (3" WC) and greater static pressure systems.

.7 Do not cross-break bottom duct panels when ductwork is handling moisture.

.8 Roof mounted ducts shall have standing seams and shall be sealed weather tight.

.9 Grade all ductwork handling moisture, a minimum of 1:120 (1" in 10 ft) back to the source or at low points in the ductwork, provide a 150mm (6") deep drain sump and 30mm (1¼") dia. drain connection with deep seal trap and pipe to drain.

.10 Construct ductwork handling moisture with three sided bottom sections and a separate top panel. Install the three sided bottom sections and internally seal the transverse joints with CGE Silicone Sealant "Silpruf". Then install the top panels and seal the top panel seams and joints.

.11 Provide moisture collection sections inside all louvres for outside air and exhaust air.

.12 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to the structure shall be compatible with the structure and selected for the load of the ductwork. Refer to Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

.13 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of the separation with silicon sealant to prevent passage of smoke and/or transmission of sound. (U.L.C. approved fire stop sealant is not a requirement). Where ducts are insulated provide a 0.61mm (24 ga) thick galvanized steel band tightly fitted around insulation and then caulk to band.

.14 Provide drip pans under piping and shields for protection of electrical panels and equipment.

.15 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450mm (18”) crossbrace for rigidity. Open corners are not acceptable.

.16 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 are specified, provide turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fiberglass inside.

.17 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal cap with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.18 Interrupt duct linings at fire, balancing, backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both side of damper device.

.19 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.

.20 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 23 33 00 – Air Duct Accessories.

.21 Do not use flexible duct to change direction. Provide a minimum of three (3) duct diameters of straight metal duct between box inlet and flexible connector.

.22 Connect diffusers to low pressure ducts with 300mm (12”) maximum stretched length of flexible duct. Hold in place with caulking compound and strap or clamp.

.23 Prove that ductwork is substantially air tight before covering or concealing.

.24 All segmented type elbows shall be spot welded. No adjustable type elbows are allowed.

.25 Hood and shaft seal.

.26 Provide discharge cone at roof outlet.

END OF SECTION

1. General

1.1 Scope

.1 Access doors (duct and plenum access)

.2 Fire dampers

.3 Balancing dampers

.4 Flexible connections

.5 Backdraft dampers

.6 Turning vanes

.7 Sealants

1.2 Quality Assurance

.1 Fire dampers shall be ULC listed and constructed in accordance with ULC Standard S112 "Fire Dampers".

.2 Fusible links on fire dampers shall be constructed to ULC Standard S505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of NFPA 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with ASHRAE Handbooks and SMACNA Duct Manuals.

.6 Flexible air duct shall comply with NFPA 90A and UL181 Standard for Factory-Made Air Ducts and Air Connectors.

.7 At job completion, demonstrate that all fire dampers operate freely and without binding, and that ratings of fire dampers meet or exceed the rating of the fire wall.

1.3 Reference Standards

.1 American National Standards Institute/National Fire Protection Association (ANSI/NFPA)

.1 ANSI/NFPA 90A Installation of Air Conditioning and Ventilating Systems.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM A 653M — Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible

.4 Underwriters Laboratories of Canada (ULC)

.1 CAN4-S112 — Fire Test of Fire Damper Assemblies.

.2 CAN4-S112.2 — Fire Test of Ceiling Firestop Flap Assemblies.

.3 ULC-S505 — Fusible Links for Fire Protection Service.

1.4 Related Work Specified in Other Sections

.1	HVAC Air Distribution System Cleaning	Section 23 01 30.51
.2	Common Work Results for HVAC	Section 23 05 00
.3	Metal Ducts	Section 23 31 13
.4	Air Outlets and Inlets	Section 23 37 00

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

.1 Submit shop drawings for review.

2. Products

2.1 Acceptable Manufacturers

.1	Access Doors	:	Controlled Air, Nailor, Air-O-Metal, Titus
.2	Backdraft Dampers	:	EH Price, Greenheck, NCA, Ruskin, Nailor
.3	Balancing Dampers	:	EH Price, Greenheck, NCA, Ruskin, Nailor
.4	Duct Hardware	:	Ventlock, Duro-Dyne, Brytex
.5	Fire Dampers	:	EH Price, Greenheck, NCA, Ruskin, Nailor
.6	Sealants	:	Ductmate

2.2 Duct Access Doors

.1 Square/Rectangular Doors: Frame shall be die-formed of 0.85mm (22 gauge) galvanized steel complete with notched knock-over tabs for installation. Door shall be die-formed 0.85mm (22 gauge) galvanized steel and be of double skin construction with 25mm (1") of insulation fully enclosed within. A positive seal, polyethylene gasket shall be secured to each door for low leakage. Door shall meet SMACNA requirements for systems up to 500 Pa (2" wc) and be hinged on one side with camlock closure. Standard of acceptance: Nailor Series 08S.

.2 Flat Oval Doors: Frame shall be of oval design, die-formed of minimum 0.70mm (24 gauge) galvanized steel with 5mm (3/16") pre-punched mounting holes. Door shall be die-formed of minimum 0.70mm (24 gauge) galvanized steel and be of double skin construction with 25mm (1") of insulation fully enclosed within. Door shall be complete with safety handle on sizes 200mm x 125mm 8"x5") thru 460mm x 250mm (18"x10"), two safety handles on larger sizes. Door shall be secured with plated steel wing nut fasteners, with bulb type seal integrally fastened to door for positive seal. Standard of acceptance: Nailor Series 0800-5.

2.3 Fire Dampers

.1 Fire dampers shall be ULC listed and labelled. Fire damper assemblies to be fire tested in accordance with CAN4-S112.

.2 Fabricate of galvanized steel or prime coated black steel weighted for static application (i.e., non-ducted) and spring operated for dynamic application (i.e., ducted), to close and lock in closed position when released by fusible link.

.3 Fire dampers shall be curtain type static weighted for non-ducted systems and dynamic spring operated for ducted systems with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.

.4 Fusible links shall be set for 73.9°C (165°F).

.5 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess (Type B) so free area of connecting ductwork is not reduced, unless noted otherwise on the drawings.

.6 Refer to architectural drawings for ratings of fire walls and provide fire dampers with compatible ratings.

2.4 Splitter Dampers

.1 Fabricate splitter dampers of double thickness sheet metal to streamline shape, properly stiffened to avoid vibration.

.2 Fabricate galvanized steel, minimum 1.6mm (16 gauge), and provide with adjustable rod and locking screw.

.3 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.5 Balancing Dampers

.1 Fabricate of galvanized steel, minimum 1.6mm (16 gauge). Full blade-length shafts of hollow square construction with blades rigidly fastened along entire blade length.

.2 Lockable quadrant type operating mechanism with end bearings on accessible rectangular ducts up to 400mm (16”) deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425mm (17”) and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275mm (11”) deep construct of single blade (butterfly) type.

.5 On rectangular ducts 300mm to 400mm (12” x 16”) deep construct of two opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425mm (17”) deep construct of multiple opposed blades, mechanically interlocked with blades no greater than 200mm (8”) deep and pivots equally spaced.

.7 On round ducts construct of single blade (butterfly) type. On 500 Pa (2” WG) class and on all dampers over 300mm (12”) diameter fabricate with full blade-length shaft.

.8 Construct damper blades for medium and high pressure systems to block air passage 70% maximum. Provide complete with locking type handles.

.9 Provide over-ride limiting stops on all operating mechanisms.

.10 Identify the air flow direction and blade rotation and open and close positions on operating mechanism.

.11 On round ductwork, install operating mechanism on a steel mounted base firmly secured to the ductwork.

.12 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.6 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 0.51mm (0.02”) thick, 150mm (6”) wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150mm (6”) intervals. Flexible connection airtight at 500Pa (2” WG).

.2 Kitchen and Fume Hood Exhausts: Flameproof air tight fibrous glass reinforced heavy asbestos cloth to NFPA 90A Class 1 and ASTM E136, UL or ULC listed.

2.7 Backdraft Dampers

.1 Frame shall be constructed of extruded aluminum with a 2.29mm (0.09”) minimum wall thickness with 2.75mm (12 gauge) galvanized steel structural braces at each corner.

.2 Blades shall be 0.64mm (0.025”) minimum roll formed aluminum with extruded vinyl blade edge seals mechanically locked into blade edge. Blades shall include field adjustable, zinc plated steel counter balance weights to allow pressure relief at less than 2.5 Pa (0.01” wc).

.3 Bearings shall be corrosive resistant, long life synthetic type for quiet operation.

.4 Linkage shall be 12mm (½”) wide tiebar concealed in frame.

.5 Dampers shall be suitable for maximum 7.6m/s (1500 fpm) spot velocities and up to 996 Pa (4” wc) back pressure..

.6 Frame shall be constructed of extruded aluminum with a 3.2mm (0.125”) minimum wall thickness with 2.75mm (12 gauge) galvanized steel structural braces at each corner.

.7 Blades shall be 1.8mm (0.07”), minimum wall thickness, extruded aluminum with extruded vinyl blade edge seals mechanically locked into blade edge. Blades shall include field adjustable, zinc plated steel counter balance weights.

.8 Bearings shall be corrosive resistant, long life synthetic type for quiet operation.

.9 Linkage shall be 12mm (½”) wide tiebar connected to stainless steel pivot pins.

.10 Dampers shall be suitable for maximum 17.8 m/s (3500 fpm) spot velocities and minimum 996 Pa (4” wc) back pressure.

2.8 Test Holes

.1 DuroDyne IP series, complete with extenders for insulation thickness, flat gaskets for rectangular ductwork and molded rubber gaskets for round ductwork. Cut holes with hole saw and deburr edges. Install test holes with rivets or bolts with head on the interior of the ductwork.

2.9 Turning Vanes

.1 Full radius arc; single blade vanes.

.2 Acoustic vanes constructed in airfoil pattern with fibrous glass padding, 0.8 mm perforated lining.

2.10 Sealants

.1 Comply with South Coast Air Quality Management District (SCAQMD) Rule #1168.

.2 Sealants to contain zero VOC and comply with LEED cr4.1 – Requirements for Low Emitting Materials.

3. Execution

3.1 Duct Access Doors

.1 Provide access door minimum 450mm x 350mm or 50mm (18”x14” or 2”) smaller than duct dimension for cleaning and inspection at positions indicated by drawings and as follows:

.1 At 6.0m (20’-0”) intervals on all horizontal ducts.

.2 At 12.0m (40’-0”) intervals in all vertical duct systems.

.3 At the base of all duct risers.

.4 Both sides of turning vanes in all ducts.

.5 At each fire damper location.

.6 At each side of all heating or cooling coils.

.7 At all locations of internally duct mounted devices including automatic dampers, damper motors, duct mounted smoke detectors and heat detectors, and control sensors and devices.

3.2 Fire Dampers

.1 Install to manufacturer’s instructions and recommendations and to the satisfaction of the authorities having jurisdiction.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install to NFPA 90A and SMACNA Standard “Fire Damper Guide for Air Handling Systems”. Refer to drawings for locations.

.3 Fire dampers shall be complete with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.4 Coordinate with the General Contractor for correct size openings and proper fire guard sleeving for fire damper penetration.

.5 At each point where ducts pass through partitions, the opening around the duct shall be sealed with non-combustible material.

.6 Ensure openings through gypsum wall-board partitions are protected in accordance with local regulations and ULC Information Bulletin No. 80-2. Maximum fire damper size through gypsum wall-board partitions shall be 1200mm wide x 1500mm high (48”x60”).

.7 All fire dampers and fire stop flaps are to be left in the closed position for balancing contractor to fix open.

.8 Support ceiling fire stops from the structure above the fire stop and not from air outlets on associated ductwork.

.9 Recess curtain type fire damper so that free area of connecting ductwork is not reduced.

.10 Provide curtain type fire dampers in duct systems with pressure greater than 250 Pa (1" WC).

.11 Provide multi-blade, offset butterfly or recessed curtain blade fire dampers on duct systems with pressure less than 250 Pa (1" WC).

3.3 Balancing Dampers

.1 Install balancing dampers on each branch of low velocity supply, return and exhaust ducts, including run outs to room air outlets and inlets.

.2 Provide balancing dampers on medium and high pressure systems where indicated. Splitter dampers shall not be used on medium and high pressure system.

.3 Single blade dampers permitted on rectangular ductwork up to 300mm maximum duct height.

.4 Do not install closer than two (2) duct widths to elbows or intersections.

3.4 Flexible Connections

.1 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on drawing. Provide for 150mm (6") spacing between ducts and equipment. Install with just sufficient slack to prevent vibration transmission.

.2 Allow 100mm (4") movement of medium pressure fans and 50mm (2") movement of low pressure fans.

.3 For connections to medium and high pressure fans, and in potentially wet locations, install 12mm (½") thick neoprene pad over fabric and hold in place with additional metal straps.

.4 Provide fire retardant flexible connectors on kitchen exhaust systems.

3.5 Backdraft Dampers

.1 Provide gravity backdraft dampers on all exhaust air outlets to outdoor and exhaust fans where motorized dampers are not indicated, and where shown on drawings.

3.6 Turning Vanes

.1 Install turning vanes in duct elbows where centerline radius is less than 1¼ times the turning dimension of the duct.

3.7 Test Holes

.1 Provide at suitable locations on each duct main at the suction and discharge of every fan to facilitate total and static pressure readings.

3.8 Motorized Dampers

.1 Install dampers furnished by the control trade.

.2 Ensure suitable clearance is provided for the installation and operation of the damper operator and linkage when setting motorized dampers in place.

END OF SECTION

1. General

1.1 Scope

.1 Flexible ducts

1.2 Definitions

.1 Low Pressure: Static pressure in duct less than 500 Pa (2 in. WG) and velocities less than 10 m/s (2000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1500 Pa (6 in. WG) and velocities greater than 10 m/s (2000 fpm).

.3 High Pressure: Static pressure over 1500 Pa (6 in. WG) and less than 2500 Pa (10 in. WG) and velocities greater than 10 m/s (2000 fpm).

.4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 Quality Assurance

.1 Use highest quality materials conforming to the appropriate ASTM and ANSI specifications.

.2 The codes and standards herein referred to shall be those editions currently in effect or accepted by the authorities having jurisdiction.

.3 Ductwork shall meet the requirements of NFPA 90A - Air Conditioning and Ventilating Systems.

.4 Flexible air duct shall conform to NFPA 90A and UL181 standard for factory made air duct materials and air duct connectors. Flexible duct shall have a Fire Rating of at least ½ hour as measured by UL Standard.

.5 Conform to the National Building Code and Provincial statutes.

1.4 Reference Standards

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)

.2 National Fire Protection Association (NFPA)

   .1 NFPA 90A — Standard for the Installation of Air-Conditioning and Ventilating Systems.

.3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)

   .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible

.2 SMACNA IAQ Guideline for Occupied Buildings under Construction

.4 Underwriters' Laboratories Inc. (UL).

.1 UL 181 Standard for Factory-Made Air Ducts and Air Connectors.

.5 Underwriters' Laboratories of Canada (ULC).

.1 CAN/ULC-S110 Fire Tests for Air Ducts.

1.5 Related Work Specified in Other Sections

.1	HVAC Air Distribution System Cleaning	Section 23 01 30.51
.2	Common Work Results for HVAC	Section 23 05 00
.3	Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29
.4	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.5	Vibration and Seismic Controls for HVAC	Section 23 05 48
.6	HVAC Insulation	Section 23 07 00
.7	Air Duct Accessories	Section 23 33 00
.8	Air Outlets and Inlets	Section 23 37 00

1.6 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 Submittals

.1 Provide shop drawings and schedules for review. Include all product information including materials of construction.

2. Products

2.1 Acceptable Manufacturers

.1 Wiremold, Flexmaster, Thermaflex.

2.2 Materials

.1 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts. Duct clamps shall be accepted for use with non-metallic flexible ducts.

.2 Sealant: Water resistant, fire resistive, compatible with mating materials.

.3 Flexible ducts to be fabricated to CAN/ULC-S110.

.4 Flexible Duct - Low Pressure: Flexible air duct shall be used where shown on drawings. Length of flexible duct shall not exceed 900mm (36”). Flexible duct shall be polymetric liner banded to a steel wire helix, wrapped with fiberglass insulation and outer fiberglass reinforced metalized vapour barrier jacket. Flexible duct rated for 25.4 m/s (5000 fpm) velocity and pressure rated for 2.49 kPa, 100mm to 300mm ID; 1.49 kPa, 350mm to 400mm ID; and 1.00 kPa, 450 to 500mm (10” wc, 4” to 12” ID; 6” wc, 14” to 16” ID; 4” wc, 18” to 20” ID) positive pressure ; and 249 Pa, 100mm to 300mm ID; 125 Pa, 350mm to 500mm ID (1” wc; 4” to 12” ID; 0.5” wc, 14” to 20” ID) negative pressure.

Standard of Acceptance: Thermaflex M-KE

.5 Flexible Duct - Medium and High Pressure: Flexible air duct may be used to connect terminal units to metal duct. Length of flexible duct shall not exceed 300mm (12”). Flexible duct shall be woven and vinyl coated fiberglass liner bonded to a steel wire helix. Where flexible air duct is attached to metal insulated duct, furnish flexible air duct with fiberglass insulation and outer fiberglass reinforced metalized vapour barrier jacket. Flexible duct rated for 30.5 m/s (6000 fpm) velocity and pressure rated for 4.0 kPa, 100mm to 250mm ID; 2.49 kPa, 300mm to 500mm ID (16” wc, 4” to 10” ID; 10” wc, 12” to 20” ID) positive pressure; and 249 Pa (1” wc) negative.

Standard of Acceptance - Un-insulated: - Thermaflex S-TL

Standard of Acceptance - Insulated: Thermaflex M-KC

3. Execution

3.1 <u>Duct Sealing</u>

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, shall be sealed using,

- .1 Low Pressure Ductwork:
  - .1 Joints: Heavy mastic type sealant.
- .2 Medium and High Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tapes as sealing method are not permitted.

.3 Surfaces to receive sealant shall be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.4 Prior to sealing all joints to ductwork, demonstrate sealing and obtain approval from the engineer.

3.2 Installation

.1 Do not use flexible duct to change direction. Provide a minimum of three (3) duct diameters of straight metal duct between box inlet and flexible connector.

.2 Connect diffusers to low pressure ducts with 300mm (12”) maximum stretched length of flexible duct. Hold in place with caulking compound and strap or clamp.

.3 Flexible ducts shall be installed as per SMACNA standards.

END OF SECTION

1. General

1.1 Scope

.1 In-line Centrifugal Duct Fans

.2 Roof Mounted Fans

.3 Bathroom Exhaust Fans

.4 Air Barriers

.5 Fan Accessories

.6 Roof Curbs

1.2 Quality Assurance

.1 All fans of any specific type on the project shall be supplied by a single manufacturer.

.2 Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal for performance and sound ratings.

.3 Fans shall bear CSA label.

1.3 Reference Standards

.1 Air Movement and Control Association International, Inc. (AMCA)

.1 AMCA 99 — Standards Handbook

.2 AMCA 300 — Reverberant Room Method for Sound Testing of Fans

.3 AMCA 301 — Methods for Calculating Fan Sound Ratings from Laboratory Test Data

.2 American National Standards Institute (ANSI) / Air Movement and Control Association International, Inc. (AMCA)

.1 ANSI/AMCA 210 — Laboratory Methods of Testing Fans for Rating.

.3 American National Standards Institute (ANSI) / American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)

.1 ANSI/ASHRAE 51 — Laboratory Methods of Testing Fans for Rating

.4 Canadian General Standards Board (CGSB)

.1 CGSB 1-GP-181M — Coating, Zinc Rich, Organic, Ready Mixed

1.4 Related Work Specified in Other Sections

.1	Common Work Results for HVAC	Section 23 05 00
.2	Common Motor Requirements for HVAC Equipment	Section 23 05 13
.3	Vibration and Seismic Controls for HVAC	Section 23 05 48
.4	Testing, Adjusting and Balancing for HVAC	Section 23 05 93
.5	Metal Ducts	Section 23 31 13
.6	Air Duct Accessories	Section 23 33 00
.7	Air Outlets and Inlets	Section 23 37 00

1.5 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place and bearings are lubricated.

.2 Refer to Section 23 05 00 – Common Work Results for HVAC.

1.8 Alternates

.1 Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that of the specified fan.

1.9 Submittals

.1 Submit shop drawings that show, as a minimum, the following:

.1 Fan size and class for application,

.2 Fan performance including capacity, external static pressure and fan speed

.3 Fan curves showing fan performance with fan and system operating point plotted on curves

.4 Dimensions

.5 Motor capacity and electrical characteristics

.6 Acoustical data

2. Products

2.1 Acceptable Manufacturers

1.	Bathroom Exhaust Fans	:	Acme, Broan, Greenheck, Penn
2.	In Line Centrifugal Duct Fans	:	Greenheck, Ammerman, Loren Cook, ACME, PennBarry
3.	Roof Mounted Fans	:	Ammerman, Greenheck, Powerline, Acme, Loren Cook, PennBarry
4.	Air Barriers	:	Berner, Enershield, Mars Air,

2.2 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Provide balanced variable sheaves for motors 11.2 kW (15 HP) and under and fixed sheave for 15 kW (20 HP) and over.

.3 Fans are to be capable of accommodating static pressure variations of ±10% with no objectionable operating characteristics.

.4 Select and design wheel and shaft so that fan does not pass through any critical speed to reach maximum operating speed.

.5 Unless otherwise indicated, equip fans with heavy duty grease lubricated ball or roller bearings of self-aligning type, with ample thrust provision to prevent end play during normal bearing life. Ensure lubricating points are readily and safely accessible after installation.

.6 Provide guard screens for fans having exposed inlet or outlets, bolted to permit removal.

.7 Supply replacement pulleys and sheaves for fans as required to properly balance the systems to design flows at actual job site static pressure conditions. Obtain requirements from balancing agency.

.8 Provide cross linkage for inlet vanes on double inlet fan.

.9 Size motors for parallel operating fans for non-overloading operation with only one fan operating.

.10 Provide belt guards with tachometer holes.

.11 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

.12 Use ground and polished steel shafts with rust preventative coating.

.13 Finish all ferrous parts with primer and baked enamel top coat.

.14 Two speed motors shall have separate winding for each speed.

2.3 Inline Cabinet Fans

.1 Description: direct drive, suspended, arrangement 4, forward curved blade, centrifugal fan.

.2 Construction:

.1 Housing: heavy gauge galvanized steel with bottom access panel.

.2 Wheel: aluminum forward curved blades, dynamically balanced.

.3 Insulation: 13mm (½”) thick acoustic insulation inside housing, neoprene coated on one side.

.4 Motor: permanently lubricated, shaded pole type, mounted on rubber vibration isolators with fan wheel directly mounted on shaft.

.5 Speed Control: provide solid state variable speed controller where noted.

2.4 Roof Mounted Fans

.1 Provide V-belt drives or direct drive motors, as noted on Fan Schedule on drawings, with fan and motor mounted to main housing through neoprene anti-vibration pads.

.2 All roof mounted fan motors shall be a minimum of 0.25 kW (1/3 HP).

.3 Heavy aluminum dome type housings and hood adequately braced and stiffened for rigidity and strength, storm and rain proof. Use heavy duty corrosion resistant hinges on hood for access. Housing to be louvered where indicated.

.4 Provide 15mm x 15mm (½” x ½”) birdscreen on discharge opening, disconnect switch and pre-manufactured roof curb.

.5 Provide multi-blade, rattle free backdraft damper, with felt lined blade edges, where indicated.

.6 Support fan wheel, motors, bearings and drive on adequate structural members and mount rotating parts on internal vibration isolators.

.7 Unit shall be complete with electrical disconnect switch.

.8 For fume hood exhaust and lab canopy exhaust fans, finish exterior steel fan parts with baked enamel primer and enamel final paint coat. Finish fan interior, including blades and other parts in contact with the air stream with two coats of acid resistant paint.

2.5 Bathroom Exhaust Fans

.1 Provide multi-blade, forward curved wheel in steel housing.

.2 Resiliently mount direct driven fan and motor. Motor shall be plug-in type with permanently lubricated bearings.

.3 Provide one piece aluminum intake grille.

2.6 Air Barriers

.1 Construction:

.1 1.5mm painted steel enclosure, 2.3m (7.5 ft) grounded power cord.

.2 Fans:

.1 Three galvanized, forward curved fans including scroll housing.

.2 Two dual speed, totally enclosed air over direct drive motors, internally protected, auto reset, 10mm shaft, bushing.

.3 Features:

.1 Painted full length discharge nozzle, full length painted steel rear mounting bracket, top intake.

.2 Integral NEMA 4 Photo electric sensor with 1.8m (6 ft) of lead, activates and deactivates the Air Barrier upon door operation, with up to 15s off delay.

.3 Sensor mounting bracket and reflector supplied, minimum sensing range of 75mm (3”).

.4 Low/Off/High 3 position keyed switch, key is removable in all 3 positions.

.5 Color: White.

.4 Certification:

.1 All air barrier units are to be CSA and ULC certified.

3. Execution

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Provide belt guards on belt driven fans complete with tachometer access.

.3 Supply and install sheaves as necessary for final air balancing.

.4 Set roof mounted fans on minimum 300mm (8”) high curbs. Provide acoustic insulation on duct to below roof line and on fan inlet plenum, and drip pan for collecting condensation with drain line to nearest drain.

3.2 Priming

.1 Prime coat fan wheels and housing factory inside and outside. Prime coating on aluminum parts is not required.

.2 Provide two additional coats of paint on fans handling air downstream of humidifiers.

3.3 Performance

.1 Refer to Fan Schedule on drawings.

.2 Refer to Air Barrier Schedule on drawings.

.3 Fan performance based on 598m (1960 ft) conditions.

END OF SECTION

1. General

1.1 Scope

.1 Supply air grilles and diffusers

.2 Return air grilles

.3 Exhaust air grilles

.4 Louvers

.5 Goosenecks

1.2 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, ASHRAE Standards and AMCA Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvers shall bear AMCA seal for free area and water penetration.

1.3 Reference Standards

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers, Inc. (ASHRAE)

.2 American Society for Testing and Materials (ASTM)

 .1 ASTM E90 Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

.3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

.4 Society of Automotive Engineers (SAE)

1.4 Job Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting shop drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.5 Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.6 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Submittals

.1 Submit diffuser and grille shop drawings that show, as a minimum, the following:

.1 Complete catalogue information

.2 Materials of construction

.3 Dimensions

.4 Accessories

.2 Submit louver shop drawings that show, as a minimum, the following:

.1 Complete catalogue information

.2 Materials of construction

.3 Pressure Drop

.4 Dimensions and free area of each louver

.5 Finish

.3 Submit color selection charts of finishes for approval prior to fabrication.

.4 Comply with requirements of Section 01 33 00 - Submittals.

2. **Products**

2.1 Acceptable Manufacturers

.1	Supply Air Grilles & Diffuser	:	EH Price, Krueger, Nailor, Titus
.2	Return Air Grilles	:	EH Price, Krueger, Nailor, Titus
.3	Exhaust Air Grilles	:	EH Price, Krueger, Nailor, Titus
.4	Security Grilles	:	Chubb, Eneround, Simpson, Virtucom
.5	Louvers & Louvered Penthouses	:	EH Price, Penn, Ruskin, Westvent

2.2 General

.1 Sizes indicated are nominal. Provide correct standard product nearest to nominal for capacity, throw, noise level, throat and outlet velocity indicated.

.2 Co-ordinate actual dimensions of grilles, diffusers and registers with adjacent building elements to result in a neat installation.

.3 Base air outlet application on space noise level of NC 30 maximum.

.4 Provide supply outlets with sponge rubber seal around the edge.

.5 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.6 Provide plaster frame for diffusers located in plaster surfaces.

.7 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

2.3 Sound Levels

.1 All grilles and diffusers shall be provided that meet the following sound level criteria:

PROGRAM SPACE	**NOISE CRITERIA (NC)**
Lobby	30
Private Offices	35
Open Offices	35-40

2.4 Grilles and Registers

.1 Formed shapes of steel or aluminum, fixed single or double deflection, vertical or horizontal face as explicit by the products specified. Provide spring tension or other device to set adjustable blades in place.

.2 Provide steel frames of cold rolled steel, with exposed joints welded and ground flush and completely closed.

.3 Provide aluminum frames extruded with mechanical fasteners and completely closed corners.

.4 Furnish where indicated integral gang operated opposed blade dampers with removable key operator, operable from face for all supply and exhaust grilles and diffusers. Use extractors on short throat connections to duct mains.

2.5 Diffusers

.1 Provide steel circular, square, rectangular or perforated type, adjustable or fixed pattern as explicit by product schedule, complete with volume controller or radial opposed blade, butterfly combination splitter or lay-in types as appropriate for installation adjustable from diffuser face.

.2 Provide sectionalizing baffles where indicated.

2.6 Linear Diffusers

.1 Provide extruded aluminum to form continuous slot outlet. Pattern and volume control device integral with slot assembly on supply units.

.2 Use conforming plug-in diffusers unless plenum ducts detailed. Diffusers to be air tight, with interior painted matte black.

.3 Use single or multiple slot width as indicated by the product scheduled.

.4 Provide blank-off strips on inactive lengths of supply units.

.5 Provide end caps of type appropriate for installation and alignment strips for multi-section continuous installation. On changes in direction, miter the corners.

2.7 Stationary Louvers

.1 Construction: Welded with exposed joints ground flush and smooth.

.2 Materials: Fabricate of 1.6mm (16 gauge) galvanized steel blades and frame.

.3 Materials: Fabricate of 2.0mm (14gauge) extruded aluminum blades and frame. Where openings exceed 1800mm (72”) in height, jamb frames shall be 2.0mm (14 gauge).

.4 Blade: storm-proof with centre watershed in blade, reinforcing bosses and maximum blade length of 1500mm (60”). Continuous blade appearance where specified.

.5 Frame, Head, Sill and Jamb: 150mm (6”) deep one piece extruded aluminum, minimum 3mm (0.12”) thick.

.6 Mullions: Spaced at 1500mm (60”) maximum centres, interior where continuous blade louvers specified.

.7 Fastenings: Stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, SS washer and aluminum body.

.8 Screen: Mesh 15mm (½”) diameter wire aluminum birdscreen on inside face of louvers in formed U-frame.

.9 Finish: Factory applied baked enamel finish. Color shall be selected by the Architect.

.10 Fabricate louvered penthouses with mitered corners and sheet roof reinforced with structural angles.

.11 Openings for non-rectangular louvers shall be field measured prior to ordering the louvers.

.12 Mount louvered penthouses on 300mm high curb base.

2.8 Gooseneck Hoods

.1 Thickness: to ASHRAE and SMACNA.

.2 Fabrication: to ASHRAE and SMACNA.

.3 Joints: to ASHRAE and SMACNA.

.4 Goosenecks to be complete with integral bird screen.

.5 Mount on 300mm (12”) high curb base where size exceeds 225mm x 225mm (9” x 9”).

3. Execution

3.1 Installation

.1 Install in accordance with manufacturer’s instructions and SMACNA recommendations.

.2 Paint ductwork visible behind air outlets matte black.

.3 Where grilles or registers are on the face of fire separations, provide fire dampers, collars, sleeves, perimeter angles as required to preserve the integrity of the separation.

.4 Provide enclosures constructed of gypsum wall-board of the same type and thickness as the ceiling to cover the sides and tops of diffusers, mounted in ceilings which form part of a fire rated assembly. Protect the inlet/outlet of the grille or diffuser at the enclosure penetration with a fire stop flap.

.5 Install louvers and goosenecks in accordance with manufacturer’s recommendations and in accordance with recommendations to SMACNA.

.6 Reinforce and brace air vents, intakes and gooseneck hoods for wind speed in accordance with ABC for location.

3.2 Performance

.1 Refer to Grille & Diffuser Schedule on drawings.

.2 Refer to Louver Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

.1 Pleated filters

.2 High efficiency bag filters

.3 Holding frames and housings

.4 Air filter gauges

1.2 Quality Assurance

.1 Filters shall be product of and supplied by one manufacturer.

.2 Filter media shall be UL listed, Class I or Class II.

.3 Filter components assembled to form filter banks shall be products of same manufacturer.

.4 Filters shall be in accordance with ASHRAE Standard 52.2-2007.

.5 Filters containing asbestos, urea formaldehyde or fibreglass shall not be acceptable.

1.3 Reference Standards

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)

.1 ANSI/NFPA 96 — Ventilation Control and Fire Protection of Commercial Cooking Operations

.2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 52.1 — Gravimetric And Dust Spot for Testing Air-cleaning Devices Used in General Ventilation for Removing Particulate Matter

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-115.10 — Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems

.2 CAN/CGSB-115.11 — Filters, Air, High Efficiency, Disposable, Bag Type (Reaffirmed April 1985)

.3	CAN/CGSB-115.12	Filters, Air, Medium Efficiency, Disposable, Bag Type (Reaffirmed April 1985)
.4	CAN/CGSB-115.13	Filter Media, Automatic Roll (Reaffirmed April 1985)
.5	CAN/CGSB-115.14	High Efficiency Cartridge Type Supported Air Filters for the Removal of Particulate Matter from Ventilating Systems
.6	CAN/CGSB-115.15	High Efficiency Rigid Type Air Filters for Removal of Particulate Matter from Ventilating Systems
.7	CAN/CGSB-115.16	Activated Carbon for Odor Removal from Ventilating Systems
.8	CAN/CGSB-115.18	Filter, Air, Extended Area Panel Type, Medium Efficiency
.9	CAN/CGSB-115.20	Polarized Media Air Filter

.4 Underwriters Laboratories of Canada (ULC)

.1	ULC -S111	"Fire Tests for Air Filter Units".
.2	ULC-S649	Grease Filters for Commercial and Institutional Kitchen Exhaust Systems.

1.4 Related Work Specified in Other Sections

.1	Common Work Results for HVAC	Section 23 05 00
.2	Air Duct Accessories	Section 23 33 00
.3	Packaged Outdoor Central Station Air Handling Units	Section 23 73 13
.4	Dedicated Outside Air Units	Section 23 74 33

1.5 Alternatives

.1 Size, media face area, material, test efficiency, initial and final air resistance of alternative manufacturers shall be as specified.

1.6 Submittals

.1 Submit shop drawings on filtration equipment specified herein.

.2 Submit instruction for operation, changing, etc., for inclusion in the maintenance manuals.

2. Products

2.1 Acceptable Manufacturers

.1 Pleated Filters : Pacific, Cambridge, AAF, Viledon, Camfil Farr.

.2 High Efficiency Bag Filters : Cambridge, AAF, Viledon, Camfil Farr.

2.2 Frames

.1 Fabricate filter frames and supporting structures of galvanized steel or extruded aluminum with necessary gasketing between frames and walls. Provide holding frames 1.6mm (16 gauge), "T" section construction, locking clips and provision for front mounted filters.

.2 Provide standard size frames to provide interchangeability of filter media of other manufacturers.

2.3 Pleated Panel Filters

.1 Media: The filter shall be constructed of non-woven reinforced cotton-synthetic fibers. A diamond grid with 98% open area shall provide support for the media. The media shall be bonded to media support to ensure pleat stability. A rigid, moisture resistant heavy duty kraft board shall enclose the media. The filter pack shall be bonded to the inside periphery of the frame to eliminate air by pass.

.2 The filter shall have a MERV 8 rating when tested in accordance with ASHRAE 52.2.

Standard of Acceptance: Camfil Farr 30/30.

2.4 High Efficiency Bag Filters

.1 Media: The filter shall consist of high-density microfine glass media chemically bonded to a permeable media support backing forming a filter blanket. Stitching centers has to be sealed through the use of a foam based sealant that shall remain pliable throughout the life of the filter. Pockets shall be formed into tapered pleats supported by controlled media space stitching.

.2 Support: Support members shall include a galvanized steel header and galvanized steel pocket retainers. The header shall be bonded to the media to prevent air bypass. Individual pocket retainers shall be fastened with a mechanical crimp to lock individual pockets together. The media pockets shall be bonded to the pocket retainers to prevent air bypass. The frame shall form a rigid and durable support assembly. A filter to filter sealing gasket shall be installed on one of the vertical members of the filter header.

.3 The filter shall be Class II listed by UL.

.4 The filter shall have a MERV 13 rating when tested in accordance with ASHRAE 52.2.

Standard of Acceptance: Camfil Farr Hi-Flo.

2.5 High Efficiency Mini-Pleated V-Bank Filters

.1 Filter media shall be lofted moisture resistant synthetic media formed into a uniform radial pleat. A welded wire grid, spot welded on one-inch centers and treated for corrosion resistance shall be bonded to the downstream side of the media to maintain radial pleats and prevent media oscillation.

.2 A biodegradable enclosing frame of Kraft board shall provide a rigid and durable enclosure. The frame shall be bonded to the media on all sides to prevent air bypass. Integral diagonal support members on the air entering and air exiting side shall be bonded to the apex of each pleat to maintain uniform pleat spacing in varying airflows.

.3 The filter shall be Class II listed by UL.

.4 The filter shall have a MERV 13 rating when tested in accordance with ASHRAE 52.2.

Standard of Acceptance: Camfil Farr Durafil ES.

2.6 Air Filter Gauges

.1 Inclined Manometer type with static pressure tips with compression fittings and flexible tubing.

.2 Range: 0 to 2 times final pressure drop.

.3 One (1) for each bank of filters and filter position.

.4 Permanent markers for initial pressure drop and recommended final pressure drop.

Standard of Acceptance: Dwyer Series 200.

3. Execution

3.1 Installation

.1 Construct and install filters to prevent passage of unfiltered air. Provide felt, rubber or neoprene gaskets.

.2 Do not operate fan system connected to filter banks until filters (temporary or permanent) are in place. Provide new filters at take-over by the Owner. Replace filters used during construction.

.3 Provide filter banks in arrangement shown with removal and access indicated.

.4 Filter Banks: provide flashing on all four sides of filter bank. Secure frames to plenum walls and to each other with rivets. Brace banks over three (3) frames high with stiffeners riveted or bolted between the frames of every row. Caulk around the perimeter of the assembled frames in the filter bank. Retain filters in factory supplied holding frames for insertion in filter bank frames. Do not fasten holding frames together to make up the filter bank frames.

.5 Provide side access housings where side removal is indicated.

.6 Ensure that overall filter frame dimensions are compatible with overall silencer dimensions when filter sections are adjacent to silencer.

.7 Provide an air filter gauge on each bank of filters including those in air handling units and alternate filter bank locations.

.8 Provide one (1) full spare set of filters at substantial completion.

3.2 Performance

.1 Refer to air handling unit and make-up air unit specification sections.

END OF SECTION

1. General

1.1 Scope

.1 Site fabricated breeching

.2 Manufactured vents and chimney for atmospheric gas fired equipment

.3 Manufactured chimneys for forced draft natural gas fired equipment

.4 Manufactured chimneys for oil fired equipment

1.2 Quality Assurance

.1 Vents, chimneys and accessories forming part of the venting system shall be ULC labeled.

.2 Comply with CSA B149.1-10 Natural Gas Installation Code

.3 Comply with the National Building code.

.4 Comply with requirements of Appliance Listing.

.5 Installation to meet all requirements of the Provincial Boiler Inspection Branch.

1.3 Definitions

.1 Appliance: a device to convert gas into energy; the term includes any component, control, wiring, piping, or tubing required to be part of the device.

- .1 Category I Appliance: this Category consists of draft-hood-equipped appliances, appliances labeled as Category I, and fan-assisted appliances for venting into Type B vents.

- .2 Category II Appliance: an appliance that operates with a non-positive vent static pressure and with a flue loss less than 17%.

- .3 Category III Appliance: an appliance that operates with a pressure and with a flue loss not less than 17%.

- .4 Category IV Appliance: an appliance that operates with a positive vent static pressure and with a flue loss less than 17%.

.2 Vent: that portion of a venting system designed to convey flue gases directly to the outdoors from either a vent connector or an appliance when a vent connector is not used.

- .1 Type B Vent: a vent complying with CAN/ULC-S605 and consisting entirely of factory-made parts, each designed to be assembled with the others without requiring field fabrication, and intended for venting gas appliances.

.2 Type BH Vent: a vent complying with ULC S636 and consisting entirely of factory-made parts, each designed to be assembled with the others without requiring field fabrication, and intended for venting gas appliances.

.3 Type L Vent: a vent complying with ULC S609 and consisting of factory-made parts, each designed to be assembled with the others without requiring field fabrication.

.3 Vent Connector: that part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and that may include a draft-control device.

.4 Venting System: a system for the removal of flue gases to the outdoors by means of a chimney, vent connector, vent, or a natural or mechanical exhaust system.

.5 Chimney: primary vertical shaft that encloses a vent.

.6 Draft: flow of air or combustion products or both, through an appliance and its venting system.

.7 Mechanical Draft: draft produced by a mechanical device such as a fan, blower, or aspirator which may supplement natural draft.

.8 Forced Draft: a mechanical draft produced by a device upstream of the combustion zone of an appliance.

.9 Induced Draft: a mechanical draft produced by a device downstream from the combustion zone of an appliance.

.10 Natural Draft: a draft other than mechanical draft.

.11 Condensing Appliance: gas fired appliance with flue loss less that 17%.

1.4 Reference Standards

.1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)

.2 Underwriters Laboratories Canada (ULC)

.1	CAN/ULC-S605-M91	Standard for Gas Vents
.2	CAN/ULC-S609-M89	Standard for Low Temperature Vents Type L
.3	CAN/ULC-S629-M87	Standard for 650 Degrees C Factory-Built Chimneys
.4	ULC-S636-08	Standard for Type BH gas Venting Systems

1.5 Related Work Specified in Other Sections

.1	Common Work Results for HVAC	Section 23 05 00
.2	Hangers and Supports for HVAC Piping and Equipment	Section 23 05 29

.3	HVAC Insulation	Section 23 07 00
.4	Commercial Gas Domestic Hot Water Heaters	Section 22 34 36
.5	Fuel Fired Unit Heaters	Section 23 55 33

1.6 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Results for HVAC.

1.7 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Results for HVAC.

1.8 Submittals

.1 Provide complete layout drawings for prefabricated chimneys including fittings, supports, connections, etc., along with product information.

2. **Products**

2.1 Acceptable Manufacturers

.1	Prefabricated Chimneys, Class A & B	:	Selkirk-Metalbestos, VanPacker, Metal Fab
.2	Category III & IV	:	Flexmaster, Heat Fab, Selkirk-Metalbestos

2.2 Vents

.1 Type A: to CAN/ULC-S604.

- .1 Application: gas and liquid fuel fired appliances.
- .2 Service Temperature: maximum flue gas temperature of 540°C (1005°F).
- .3 Double wall “Class A” stack with outer jacket of aluminum coated steel, 0.63 (.025”) thick for 150mm to 600mm diameter, 650mm diameter and larger to be 0.86mm (.034”) thick.
- .4 Minimum 25mm (1”) air space between wall.
- .5 Inner wall to be 0.89mm (.035”) thick type 304 stainless steel.
- .6 Joints to be sealed with V bands and sealant as recommended by manufacturer.
- .7 Exterior components to be supplied with factory prime coat finish suitable for field painting.
- .8 Provide all fittings necessary for installation including, but not limited to, elbows, adjustable and variance length sections, wyes, tees, drain tee caps, tapered

increases/reducers, step increasers/reducers, bucket drains, bellows joint, flange adapters, drain sections, insulated exit cones, open stack closure rings, stack caps, half channel bands, roof and wall thimbles, roof support assemblies, storm collars and flashings, flanges, supports, guides and guy components.

.2 Type A-2 Vent: to CAN/ULC-S629.

.1 Application: gas, liquid and solid fuel fired appliances.

.2 Service Temperature: maximum flue gas temperature of 650°C (1200°F).

.3 Type B Vent: to CAN/ULC-S605-M91.

.1 Application: Listed Category I appliances.

.2 Service Temperature: Maximum flue gas temperature of 243°C (470°F).

.3 Minimum 13mm (½”) air space between wall.

.4 Inner wall to be 0.89mm (.035”) thick type aluminum alloy.

.5 Joints to be sealed with V bands and sealant as recommended by manufacturer.

.6 Provide all fittings necessary for installation including, but not limited to, elbows, adjustable and variance length sections, wyes, tees, drain tee caps, tapered increasers/reducers, step increasers/reducers, bucket drains, bellows joint, flange adapters, drain sections, insulated exit cones, open stack closure rings, stack caps, half channel bands, roof and wall thimbles, roof support assemblies, storm collars and flashings, flanges, supports, guides and guy components.

.4 Type BH Vent: to ULC-S636-08

.1 Application: Listed Category II, Category III or Category IV appliances

.2 Service Temperature: Flue gas temperature up to 270°F (518°F).

.5 Type BW Vent: to CAN/ULC-S605.

.1 Application: Gas fired recessed heaters.

.2 Service Temperature: maximum flue gas temperature of 243°C (470°F).

.6 Type L Vent: to CAN/ULC-S609-M89.

.1 Application: Listed combination gas and oil burning appliance.

.2 Service Temperature: maximum flue gas temperature of 298°C (570°F).

2.3 <u>Materials</u>

.1 Comply with materials specified in CAN.ULC-S605 for Type B venting systems.

.2 Notwithstanding the optional materials specified in ULC-S636-08 supply and install AL29-7G stainless steel inner liner and 430 stainless steel outer liner, sealed, and suitable for Type BH venting systems.

.3 Comply with materials specified in CAN/ULC-S609 for Type L venting systems.

2.4 Breeching

.1 Breeching Type 1: for natural draft, gas burning appliances with draft hoods, use one of the following:

.1 Galvanized steel with thicknesses as follows:

Vent Diameter	Minimum Thickness
Smaller than 125 mm (5”)	0.4 mm (30 gauge)
125 mm to 200 mm (5” to 8”)	0.5 mm (28 gauge)
Larger than 200 mm (8”)	0.6 mm (26 gauge)

.2 Breeching constructed of same vent components as chimney.

.2 Breeching Type 2: for forced, induced, or natural draft with dilution, gas or liquid fuel fired appliances, use one of the following:

.1 Mild steel, all welded construction with thicknesses as follows:

Vent Diameter	Minimum Thickness
300 mm (12”) and smaller	1.3 mm (18 gauge)
325 mm to 600 mm (13” to 24”)	1.6 mm (16 gauge)
625 mm to 900 mm (25” to 36”)	2.0mm (14 gauge)
925 mm (37”) and larger	3.0mm (12 gauge)

.2 Breeching constructed of same vent components as chimney.

.3 Breeching Type 3: for solid fuel fired appliances, use one of the following:

.1 Mild steel, minimum thickness of 3mm (12 gauge), all welded constructed, lined with 50mm (2”) thick castable refractory.

.2 Breeching constructed of same vent components as chimney.

2.5 Accessories

.1 Cleanouts: Bolted, gasketted type, full size of breeching area.

.2 Appurtenances: Raincap, thimbles, support brackets and guys, flashing and counter flashings, fly ash screen, and other materials required to complete the assembly.

3. Execution

3.1 Vent Installation

.1 Install venting system, complete with accessories and appurtenances, in accordance with:

  .1 Appliance manufacturers certified rating.

  .2 Appropriate CAN/ULC standard for the venting system.

  .3 Appliance manufacturers installation instructions.

  .4 National Building Code.

  .5 CAN/ULC B149.1-10.

.2 Prior to ordering venting materials and prior to installation secure appliance listings and venting instructions from all appliance vendors listed in Article 1.2 - Related Work Specified in Other Sections.

.3 Do not penetrate flue gas chamber of vent with screws or mechanical fasteners.

.4 Install breeching with positive slope upward from appliance.

.5 Suspend breeching using trapeze hangers at 1500mm (5’-0”) centers.

.6 Extend chimneys to minimum 1.2m (4’-0”) above roof.

.7 Install cleanout at base of chimney.

.8 Support chimney at bottom, roof and intermediate levels.

.9 Support stacks independent of equipment served.

.10 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney.

.11 Install raincap on chimney outlet.

.12 Install counterflashing where chimneys pass through roof.

.13 Provide full angle ring and two-point rigid pipe guys to support stack above roof. Secure with anchors to structure. Co-ordinate installation with roofing contractor.

.14 Terminate double wall chimney with open stack ring to seal air space.

.15 Provide for expansion and contraction of chimney and breeching.

END OF SECTION

1. General

1.1 Scope

.1 Gas fired unit heaters.

1.2 Quality Assurance

.1 Units shall be certified by CSA to ANSI Z83.8b and CSA 2.6b for commercial/industrial installation.

.2 Units shall conform to all Provincial and Municipal codes.

1.3 Warranty

.1 Provide 1 year parts warranty on heat exchangers.

1.4 Submittals

.1 Comply with the requirements of Section 01 00 10 – General Requirements.

.2 Shop drawings shall indicate, at a minimum, the following information:

- .1 Gas input capacity
- .2 High altitude output capacity
- .3 Maximum gas operating pressure
- .4 Venting connection and combustion air inlet sizes and materials
- .5 Electrical information including:
  - .1 Volts/Phase/Hertz
  - .2 Fan motor (W)
  - .3 Full load amps
  - .4 Wiring diagram

2. Products

2.1 Acceptable Manufacturers

.1 Reznor, Lennox, Modine, Sterling

2.2 Type

.1 Provide a high efficiency, separated combustion, power vented, gas fired unit heater factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, gas burner and controls.

2.3 Construction

.1 Cabinet: Heavy gauge galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner. The cabinet shall be designed for ceiling suspension.

.2 Provide roll formed horizontal louvers. Louvers shall be spring held and adjustable for directing airflow.

.3 Heat Exchanger: Tubes shall be corrosion resistant aluminized steel.

.4 The cabinet shall be equipped with a full safety fan guard.

.5 The service cabinet shall be fully gasketed and equipped with a safety interlock switch. All components in the gas train, all standard electrical controls, and the power venter shall be within the sealed service compartment.

2.4 Burner

.1 Gas Burner: Atmospheric type with adjustable combustion air supply, equipped with combination gas valve and pressure regulator incorporating manual shut-off, pilot valve, automatic 100% shut-off and thermocouple pilot safety device.

.2 Gas Burner Safety Controls: Thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

2.5 Burner Operating Controls

.1 Low voltage, adjustable room thermostat, controls burner operation to maintain room temperature setting.

.2 Controls shall include a single-stage gas valve, direct spark multi-try ignition with electronic flame supervision with timed lockout integrally controlled via a printed circuit control board.

.3 The control board shall also incorporate diagnostic lights, DIP switches for fan overrun settings and a relay for fan only operation.

.4 High limit control, with fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature and energizes burner when temperature drops to lower safe value.

.5 All controls shall be enclosed in a sealed control compartment to protect them from accidental damage, dust and atmospheric corrosion. The control compartment door shall be gasketed and be equipped with a safety interlock switch to prevent operation when the door is open.

2.6 Combustion Air and Venting

.1 The unit shall have a factory installed, power venter device to draw combustion air from outside of the building.

.2 The open drip proof motor and fan assembly shall be resiliently mounted to the cabinet to reduce vibration and noise.

.3 The unit shall be provided with a combustion air pressure switch.

.4 Combustion air and vent piping shall be run in parallel to a factory supplied concentric adapter assembly.

.5 Refer to Section 23 51 10 – Breeching and Chimneys.

2.7 Electrical

.1 Supply voltage connections shall be made in a sealed junction box.

.2 24 Volt control connections shall be made on an externally mounted terminal strip.

.3 All internal wiring, both line and control voltages, shall be terminated by insulated terminal connections.

.4 All units to be equipped with a built in disconnect switch.

.5 Each unit shall be equipped for use with a 115V/1 Phase/60 Hz power supply.

3. Execution

3.1 Installation

.1 Unit shall be suspended from structure as recommended by manufacturer.

.2 Gas input and output ratings indicated are for 598m (1960 ft) altitude.

.3 Refer to Gas Fired Unit Heater Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

.1 Packaged roof top heating/cooling air handling units

.2 Operating controls

.3 Roof mounting frame

1.2 Quality Assurance

.1 Meet the requirements of CSA, Provincial and Municipal Codes and be CSA listed.

.2 Test and rate cooling systems to ARI Standard 210.

.3 Substitution of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded.

.4 All units and major components shall be product of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products. The units shall be products of manufacturers who provide local service personnel from factory representative, franchised dealer or certified maintenance service shop.

.5 The unit shall be fully assembled, wired and tested prior to shipment. A detailed pre-shipment report shall be provided to the Engineer. If necessary, the unit may be broken down for shipment.

.6 Provide start-up service by factory trained representative, to make adjustments, make efficiency tests, start-up units, train and instruct owners’ personnel.

.7 Operationally test after installation.

.8 Fans shall conform to AMCA bulletins regarding construction and testing and shall bear AMCA certified rating seal.

.9 Filter media shall be UL listed, Class I or Class II as approved by local authorities.

.10 Supply replacement pulleys and sheaves for fans as required to properly balance the systems to design flows at actual job site static pressure conditions. Obtain requirements from balancing agency.

1.3 Reference Standards

.1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)

.1 ANSI/ARI 210/240 Unitary Air-Conditioning and Air-Source Heat Pump Equipment

.2 ARI 270 Sound Rating of Outdoor Unitary Equipment

.2 ANSI/UL 465 Air Conditioners, Central Cooling

.3 Canadian Standards Association (CSA)

.1 CSA B52 Mechanical Refrigeration Code.

.2 CSA C22.1 HB Canadian Electrical Code, Handbook.

.4 Alberta Roofing Contractors Association (ARCA)

.5 National Fire Protection Association

.1 NFPA 90A Installation of Air Conditioning and Ventilating Systems.

.6 National Research Council (NRC)/Institute for Research in Construction.

.1 National Energy Code of Canada for Buildings (NECB) 2011

1.4 Related Work Specified in Other Sections

.1 Common Work Results for HVAC Section 23 05 00

1.5 Warranty

.1 Provide 5 years unconditional parts warranty on heat exchangers.

.2 Provide 5 year unconditional parts warranty on compressor unit.

1.6 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.7 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 Submittals

.1 Submit shop drawings that show, as a minimum, the following:

.1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

.2 Piping, valves, fitting shipped loose showing final location in assembly.

.3 Control equipment shipped loose, showing final location in assembly.

.4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

.5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.

.6 Fan performance curves.

.7 Details of vibration isolation.

.8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

.9 Type of refrigerant used.

2. Products

2.1 Acceptable Manufacturers

.1 Carrier, Daikin, Engineered Air, JCI/York, Lennox, Trane

2.2 Type

.1 Provide roof mounted type units with gas burner and electric refrigeration.

.2 Units shall be self-contained packaged, factory, assembled and pre-wired consisting of a cabinet and frame, supply fan, return fan, heat exchanger and burner, controls, air filter, refrigerant cooling coil, compressor condenser coil and fan, economizer section, and remote panel.

2.3 Construction

.1 Cabinet: Heavy gauge steel with baked enamel finish, hinged access doors with locking door type handle or panels with quick fastener. All access panels shall be easily removable for servicing. Structural members shall be minimum 1.3 mm (18 gauge) with removable panels minimum 1.0 mm (20 gauge)

.2 Insulation: Neoprene coated glass fibre on surfaces where conditioned air is handled. Protect edges from erosion. 50mm (2”) minimum thickness.

.3 Heat exchangers: Stainless steel of welded construction.

.4 Supply and Return Fan: Centrifugal type rubber mounted V-belt drive, adjustable variable pitch motor pulley rubber isolated hinge mounted motor. Complete fan assembly shall be isolated.

.5 Air Filters: Provide MERV 8 pre-filters and MERV 13 final filters in metal frames, arranged for easy replacement.

2.4 Burner

.1 Gas Burner: Induced draft two stage type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark ignition, flame sensing device and automatic 100% shut-off.

.2 Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven. Stop gas flow on ignition failure. Energize blower motor. After air flow proven and slight delay, gas valve is allowed to open.

.3 High limit control with fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature and energizes burner when temperature drops to lower safe value.

.4 Control supply fan in accordance with bonnet temperature and independent of burner controls. Include switch for continuous fan operation.

2.5 Evaporator Coil

.1 Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection, capillary tubes on units up to and including 21.0 kW (72 mbh) cooling capacity, and distributors/expansion valves on units larger than 21.0 kW (72 mbh) cooling capacity.

.2 Where multiple compressors are provided, a single cooling coil assembly shall be provided with interlaced/alternate refrigerant circuits for both face and depth to provide full coil coverage at all stages. Provide distributor/expansion valves for each refrigerant circuit, irrespective or cooling capacity, with circuiting from each compressor to provide full face and depth coverage.

.3 Solenoids shall be provided in all cases, irrespective of capacity, for each refrigerant circuit, interlocked to the respective compressor.

2.6 Compressor

.1 Provide hermetic or semi-hermetic compressor, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, service valves and filter drier.

.2 Timed off circuit shall limit number of compressor starts to 12 per hour.

.3 Outdoor thermostat shall allow compressor operation above 14°C (57°F) ambient.

.4 Provide step capacity control by hot gas bypass set-up.

2.7 Condenser

.1 Provide copper tube aluminum fin coil assembly with sub-cooling rows.

.2 Provide direct drive axial fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.

.3 Provide refrigerant pressure switch to cycle condenser fan.

2.8 Economizer section

.1 Provide remote controller outside and return air dampers with damper operator and remote potentiometer package for adjusting outside air quantity.

.2 Mixed Air Controls: Maintain selected mixed air temperature lock out compressor below approximately 14°C (57°F) ambient, return dampers to minimum position above approximately 23°C (74°F).

2.9 Operating Controls

.1 The BAS shall replicate the requirements for the remote room thermostat. The remote connections shall include fan control, 2 stage heating and 2 stage cooling control to the AHU unit.

.2 The necessary interlocks to the internal gas heating and DX cooling shall be part of the integral controls of the AHU unit.

3. Execution

3.1 Installation

.1 Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services.

3.2 Maintenance

.1 Provide bi-annual refrigerant pressure testing as per the Federal Halocarbon Regulations and client requirements.

3.3 Performance

.1 Refer to Roof Top Unit Schedule.

.2 Rated cooling capacity is based on 35°C (95°F) condenser ambient air.

.3 Supply and return air is corrected to 598m (1960 ft) altitude.

END OF SECTION

1. General

1.1 Scope

.1 Packaged indirect fired make-up air unit(s)

.2 Remote panel

.3 Roof curb

1.2 Quality Assurance

.1 Meet the requirements of CSA, Provincial and Municipal Codes and be CSA listed.

.2 Test and rate cooling systems to ARI Standard 210.

.3 Substitution of any product other than that specified, must assure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded.

.4 All units and major components shall be product of manufacturer regularly engaged in production of such units who issues complete catalogue data on such products. The units shall be products of manufacturers who provide local service personnel from factory representative, franchised dealer or certified maintenance service shop.

.5 The unit shall be fully assembled, wired and tested prior to shipment. A detailed pre-shipment report shall be provided to the Engineer. If necessary, the unit may be broken down for shipment.

.6 Provide start-up service by factory trained representative, to make adjustments, make efficiency tests, start-up units, train and instruct owners' personnel.

.7 Operationally test after installation.

.8 Fans shall conform to AMCA bulletins regarding construction and testing and shall bear AMCA certified rating seal.

.9 Filter media shall be UL listed, Class I or Class II as approved by local authorities.

.10 Supply replacement pulleys and sheaves for fans as required to properly balance the systems to design flows at actual job site static pressure conditions. Obtain requirements from balancing agency (Refer to Section 23 05 93, Testing, Adjusting and Balancing for HVAC Systems.)

1.3 Reference Standards

.1 American National Standards Institute (ANSI)/Air Conditioning and Refrigeration Institute (ARI)

.1 ANSI/ARI 210/240 Unitary Air-Conditioning and Air-Source Heat Pump Equipment

.2 ARI 270 Sound Rating of Outdoor Unitary Equipment

.2 ANSI/UL 465 Air Conditioners, Central Cooling

.3 Canadian Standards Association (CSA)

.1 CSA B52 Mechanical Refrigeration Code.

.2 CSA C22.1 HB Canadian Electrical Code, Handbook.

.4 Alberta Roofing Contractors Association (ARCA)

.5 National Fire Protection Association

.1 NFPA 90A Installation of Air Conditioning and Ventilating Systems.

.6 National Research Council (NRC)/Institute for Research in Construction.

.1 National Energy Code of Canada for Buildings (NECB) 2011

1.4 Related Work Specified in Other Sections

.1 Common Work Results for HVAC Section 23 05 00

1.5 Alternatives

.1 Size, NBS test efficiency, initial and final resistance of alternate manufacturers' filters shall be same as types specified.

.2 Pressure drops and such features as cleanability, service access, frames and supports, shall be the same as types specified.

1.6 Warranty

.1 Provide 5 year unconditional parts warranty on heat exchangers.

1.7 Delivery & Storage

.1 Deliver and store materials in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.8 Waste Management and Disposal

.1 Separate waste materials for reuse and recycling in accordance with Section 23 05 00 – Common Work Results for HVAC.

1.9 Submittals

.1 Submit shop drawings that show, as a minimum, the following:

.1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.

.2 Piping, valves, fitting shipped loose showing final location in assembly.

.3 Control equipment shipped loose, showing final location in assembly.

.4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.

.5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.

.6 Fan performance curves.

.7 Details of vibration isolation.

.8 Estimate of sound levels to be expected across individual octave bands in dB referred to A rating.

.9 Type of refrigerant used.

2. Products

2.1 Acceptable Manufacturers

.1 Engineered Air, Bousquet, Reznor

2.2 Type

.1 Provide blow-through, packaged indirect fired make-up air unit of unitary design, suitable for medium pressure operation and in configurations as shown on the drawings.

.2 Unit shall consist of basic fan filter section plus accessories, including coil section, compressor condenser coil and fan, air filter, indirect gas fired heat exchangers, motorized outdoor air damper, inlet hood, roof curb, remote pane.

2.3 Unit Construction

.1 Unit casing shall be of minimum 1.3 mm (18 gauge) satin coated galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two part acid based etching primer. Finish coat shall be air dried polyurethane on all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws. Wall and floor joints shall be broken in and roof to be constructed of 50 mm (2”) standing seam overlapping construction with continuous roof pans with 50 mm (2”) down turn outer edge with 15 mm (½”) rain deflection outer break, maximum width 600 mm (24”) sections. No screw penetrations are permitted in top of roof. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components:

.1 Fans and Motors

.2 Filters

.3 Access Plenums

.4 Controls

.4 Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable. Doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in.

.1 Provide hinged access doors, fully lined with stainless piano hinges with a minimum of two tool operated fasteners.

.2 Camlock fasteners are not acceptable.

.5 Casings shall be supported on formed galvanized steel channel or structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

2.4 Insulation

.1 All units shall be internally insulated with 50 mm (2”) 24 kg/m^3 (1 ½ lb./cu.ft.) density, neoprene coated fibreglass thermal insulation, secured to metal panels with a fire retardant adhesive and welded steel pins at 400 mm (16”) on centre. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

2.5 Fan Assembly

.1 Forward curve, double inlet, statically and dynamically balanced Class II centrifugal fan. Heavy duty shaft and pre-lubricated self-aligning bearings, rubber mounted V-belt drive, adjustable variable pitch motor pulley, rubber isolated hinge mounted motor.

.2 Fan motor assembly shall be mounted on a free floating angle iron frame and internally isolated from rest of the unit using base isolators and canvas connectors.

.3 Fans shall be equipped with pillow block bearings with extended grease lines.

.4 Drives shall be adjustable on fans with motors 3.75 Kw (5 HP) or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide drive changes (if required) during the air balance procedure.

.5 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly. Motor mounting shall be adjustable to allow for variations in belt tension.

.6 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be secured to welded steel channel and connected to the structural frame of the unit. The isolators shall be neoprene-in-shear type. Hard mounted fan assemblies are not acceptable.

.7 Fan motors shall be open drip proof type.

2.6 Filters

.1 Refer to Section 23 41 00 – Particulate Air Filtration for detailed filter specifications.

.2 Filters containing urea formaldehyde or fibreglass are not acceptable.

.3 Provide MERV 8 pre-filters and MERV 13 final filters in metal frames, arranged for easy replacement.

2.7 Gas Fired Heat Exchanger

.1 Heating units shall have an indirect natural gas fired heating section that is CGA approved for both seal level and high altitude areas.

.2 Heat exchangers shall be 409 SS and have minimum of 1mm (20 gauge) tubes and 1.6mm (16 gauge) headers and burners are to have stainless steel burner port protector and air shutters.

.3 Fuel trim shall have a solid state ignition control with ignition only on a call for heat.

.4 Units shall have induced draft combustion (power vented) with safety switch proving combustion air before activation of the gas valve.

.5 Gas valve shall be fully modulating energized through Duct thermostat w/ room thermostat override.

.6 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure this device will shut down the fan and close the outdoor air damper. This device shall require re-setting by interrupting the electrical circuit.

2.8 Compressor

.1 Provide hermetic or semi-hermetic compressor, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, service valves and filter drier.

.2 Timed off circuit shall limit number of compressor starts to 12 per hour.

.3 Outdoor thermostat shall allow compressor operation above 14°C (57°F) ambient.

.4 Provide step capacity control by hot gas bypass set-up.

2.9 Condenser

.1 Provide copper tube aluminum fin coil assembly with sub-cooling rows.

.2 Provide direct drive axial fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor.

.3 Provide refrigerant pressure switch to cycle condenser fan.

2.10 Evaporator Coil

.1 Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection, capillary tubes on units up to and including 21.0 kW (72 mbh) cooling capacity, and distributors/expansion valves on units larger than 21.0 kW (72 mbh) cooling capacity.

.2 Where multiple compressors are provided, a single cooling coil assembly shall be provided with interlaced/alternate refrigerant circuits for both face and depth to provide full coil coverage at all stages. Provide distributor/expansion valves for each refrigerant circuit, irrespective or cooling capacity, with circuiting from each compressor to provide full face and depth coverage.

.3 Solenoids shall be provided in all cases, irrespective of capacity, for each refrigerant circuit, interlocked to the respective compressor.

2.11 Controls

.1 Air Handling Units shall be factory wired and tested, and shall be certified by CSA, CGA.

.2 Wiring shall be in accordance with the Canadian Electrical Code, Part 1, and pertinent sections of Part 2 of the Code pertaining to specific equipment type and purpose.

.3 All electrical circuits shall undergo a dielectric strength test (CSA C22.2-0), and shall be factory tested and checked as to proper function.

.4 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.

.5 Provide a system of automatic temperature control, contained within the air handling units for total control of the unit.

.6 Provide for each air handling unit a dedicated terminal strip for connection to a BAS system.

.1 DI – Digital input to MUA from BAS to enable unit

.2 DI – Digital input to MUA from BAS to enable heating

.3 DI – Digital input to MUA from BAS to enable cooling

.4 DO – Digital output from MUA to BAS for common alarm

.5 AI – Analog input from BAS to MUA to change supply air setpoint.

2.12 Outdoor Units

.1 Air Handling Units shall be weatherproofed and equipped for installation outdoors. The design shall be generally for the prevention of infiltration of rain and snow into the unit, and more specifically includes:

.1 Louvres or hoods on air intakes and exhaust openings with 25mm (1”) galvanized inlet screens.

.2 Rain gutters over hinged access doors.

.3 All joints caulked with a water resistant sealant.

.4 Roof joints turned up 50 mm (2”) with interlocking design.

.5 Outer wall panels extend a minimum of 20 mm (¾”) below the floor panel.

.6 Units mounted on roof curbs shall incorporate a welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked and tarred.

.7 Unit perimeter base frame shall be internally insulated. Bare channel base frames are not acceptable.

.2 Provide full perimeter roof mounting curb of heavy gauge sheet metal, minimum of 300 mm (12”) high. External insulation of the roof mounting curb shall be provided by the Roofing Subcontractor.

.3 Gas fired units shall be approved for operation in -40°C (-40°F) locations.

3. Execution

3.1 Assembly

.1 Mount roof top units on factory supplied roof curbs.

3.2 Maintenance

.1 Provide bi-annual refrigerant pressure testing as per the Federal Halocarbon Regulations and client requirements.

3.3 Unit Schedule

.1 Gas input and output ratings indicated are for 560m (1840 ft) altitude.

END OF SECTION

1. General

1.1 Scope

.1 Room air conditioner.

.2 Remote Condensing Unit.

.3 Refrigerant.

.4 Controls.

1.2 Quality Assurance

.1 Provide factory assembled, package type unitary air conditioning unit, product of manufacturer regularly engaged in production of unit of type and size specified, who issues complete catalogue data on such products. Unit shall be factory built and tested.

.2 Manufacturer shall be responsible for selection and operation of components furnished by him. Provide written certification that components not furnished by him have been selected in accordance with his requirements.

.3 Unit shall be factory built and tested.

.4 Unit shall be CSA approved and listed.

.5 The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

.6 The units shall be rated in accordance with ARI Standard 210 and bear the ARI label.

.7 The outdoor unit shall be pre-charged for 70 feed of refrigerant tubing.

.8 Helium holding charge shall be provided in the evaporator.

.9 System efficiency shall meet or exceed 13.0 SEER.

.10 The manufacturer shall have a factory trained service and maintenance provider located in Edmonton.

1.3 Warranty

.1 The units shall have a manufacturer’s warranty for a period of one (1) year from date of installation. The compressor shall have a warranty of six (6) years from date of installation. If during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

1.4 Submittals

.1 Shop drawings shall include: Single line diagrams; Dimensional; Electrical and capacity data; Piping and electrical connection drawings.

.2 Comply with the requirements of Section 01 33 00 – Submittal Procedures.

2. Products

2.1 Acceptable Manufacturers

.1 Mitsubishi, Daikin, Panasonic, Fujitsu

2.2 Refrigerant

.1 The system shall use R410A refrigerant.

2.3 Indoor unit

.1 The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit in conjunction with the remote controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit refrigerant pipes will be charged with helium air before shipment from the factory.

.2 Unit Cabinet

.1 The casing shall be ABS plastic and have a munsell 3.4Y 7.7/0.8 finish. Multi-directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard. There shall be a separate back plate which secures the unit firmly to the wall.

.3 Fans

.1 The evaporator fan shall have a line flow fan driven by a single motor. The fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. Manual adjustable louvers shall be provided to laterally change direction of airflow. A motorized vane shall close the outlet port when operation is stopped. It shall also automatically direct air flow in a vertical direction for uniform air distribution. The indoor fan shall consist of two (2) speeds, Hi and Low.

.4 Filter

.1 Return air shall be filtered by means of an easily removed washable filter.

.5 Coil

.1 The evaporator coil shall be of nonferrous construction with aluminum strake pre-coated fins on copper tubing. All tube joints shall be razed with phos-copper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

.6 Electrical

.1 The unit electrical power shall be 208 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The unit shall have an optional, shared power supply between indoor and outdoor units or individual power supply.

.7 Controls

.1 This unit shall have a wired controller to perform input functions necessary to operate the system. The wire controller shall have multi-language, a large DOT liquid crystal display and a weekly timer with eight pattern settings per day. The controller shall consist of an On-Off switch, Cool/Dry-Fan selector, Thermostat setting, Timer Mode, High-Low fan speed, Auto Vane selector, Test Run switching and Check Mode switching. The controller shall have a built in temperature sensor. Temperature changes shall be by 1°F increments with a range of 19-30°C (67-87°F). Temperature displayed in both °F and °C. The control system shall consist of two (2) microprocessors interconnected by a single non-polar two wire cable.

.2 Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room.

.3 The controller shall have the capability of controlling up to a maximum of sixteen systems at a maximum developed control cable distance of 457 meters (1,500 feet).

.4 Field wiring shall run direct from the indoor unit to the controller with no splices. Manufacturer shall provide two (2) conductor non-polar 22 AWG. stranded wire for connection to remote controller.

.5 The system shall include self-diagnostics including total hours of compressor run time., Diagnostics codes for indoor and outdoor unit shall be displayed on wired remote panel. Controller shall display operating conditions such as pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions, including (running current, frequency, input voltage, on/off status and operating time), LEV opening pulses sub cooling and discharge super heat.

.6 The microprocessor within the wall mounted remote controller shall provide automatic cooling, display set point and room temperature. Control system shall control the continued operation of the air sweep louvers, as well as provide on/off and system/mode function switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay. Two remote controllers can be used to control one unit.

.7 The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit. The control voltage from the controller to the indoor unit shall be 12 volts DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. The system shall be capable of automatic restart when power is restored after power interruption.

.8 The room temperature is to be monitored by a room temperature sensor connected to the BAS. Refer to section 23 09 93.

2.4 Outdoor Unit

.1 The outdoor unit must be of the same capacity as the indoor unit. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all functions necessary for operation. The outdoor unit shall contain Variable Compressor Speed inverter Technology. The outdoor unit shall be capable of operating at -18°C (0°F) ambient temperature without additional low ambient controls (optional wind baffle may be required). The outdoor unit must have the ability to operate with a maximum height difference of 30.5 meters (100 feet) and have a maximum refrigerant tubing length of 50.3 meters (165 feet). Each unit must be test run at the factory.

.2 The outdoor unit shall be shipped re-charged with refrigerant.

.3 Cabinet

.1 The casing shall be constructed from galvanized steel plate and finished with acrylic paint munsell 3Y 7.8/1.1. The fan grille shall be of ABS plastic.

.4 Fan

.1 The motor bearing shall be permanently lubricated. The fan blade shall be aerodynamic design for quiet operation. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front.

.5 Coil

.1 The L shaped condenser coil shall be of copper tubing with flat aluminium fins to reduce debris build up. The coil shall be protected with an integral metal guard.

.2 Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be controlled by a microprocessor controlled step motor.

.6 Compressor (VCSI)

.1 The compressor shall be a rotary compressor with variable compressor speed inverter technology (VSCI). The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall match the room load to significantly increase the efficiency of the system which results in vast energy savings. During the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor, to maintain enough heat to prevent liquid from accumulating in the compressor. The outdoor unit shall have an accumulator and high pressure safely switch.

.7 Electrical

.1 The unit electrical power shall be 208 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have pulse amplitude modulation circuit, this shall enable the unit to use 98% of input power supply.

.8 Ultra Low Ambient Package

.1 Ultra Low Ambient systems are shipped with ultra low ambient package factor installed.

.2 Each unit is integrated with electronic control systems to provide dependable operation during adverse conditions.

.3 Wind shields are provided separately to protect the unit from prevailing winds.

.4 Ultra Low Ambient option to allow system to operate down to (-40°F) -40°C in cooling mode.

3. Execution

3.1 Installation

.1 The fixing of all air conditioning equipment, installation of all refrigerant pipework and full commissioning shall be performed by a specialist refrigerant installer authorized by the manufacturer to install the system.

.2 The installation of all internal and external units, refrigerant pipework, inter-connecting wiring, commissioning and testing shall be carried out by an approved refrigerant systems installers, and in accordance with manufacturer’s installation instructions.

.3 Units to be installed plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

.4 Install and connect electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish cop of manufacturer’s electrical connection diagram submittal to electrical contractor.

.5 Install and connect devices furnished by manufacturer but not specified to be factory mounted.

.6 Connect condensate drain to air evaporator unit. Unit drain shall be trapped internally.

.7 Full access shall be afforded to site during the installations stage of the project to allow manufacturer’s representatives to verify that installation methods are fully in accordance with manufacturer’s requirements.

.8 Refrigerant Pipework:

.1 Supply, install, test and commission all interconnecting refrigeration pipework between the outdoor and indoor units.

.2 All pipework to be carried out in refrigerant quality ACR copper tubing and complete with the appropriate headers and joints. All pipework must be suitable for R410A.

.3 Longest possible lengths of copper pipe should be utilized to minimize joints on site.

.4 Appropriate refrigeration installation tools must be utilized. Dry Nitrogen must be utilized at all times in the system during brazing.

.5 All pipework (suction and liquid lines) to be insulated with slip on close cell elastomeric pipe insulation (as manufactured by Armaflex or equal and approved) having a wall thickness of not less than ½”.

.6 After installation of pipework, and prior to sealing of insulation joints and starting of equipment, pipework should be pressure tested. 44 PSIG test for 3 minutes minimum, then 217 PSIG for 3 minimum, then 478 PSIG for 3 minutes minimum, then strength test to 600 PSIG check the system for leaks and deformation, then lower the pressure back to 478 PSIG and pressure test for 24 hours and checked for leaks. Vacuumed/dehydrated to 300 microns, and hold at that vacuum for 12 hours (minimum)

.7 Refrigerant (R410A) charge weight must be calculated, to the actual installed length of pipe work in accordance to manufacturer’s recommendations.

.8 The charging should be carried out with an appropriate charging station.

.9 Pipework to be properly fixed and supported at a minimum of 1.5 metres (5 feet) centres or as specified by local code and where required should be run on galvanized trays. All pipework to be labelled with ID number (condensing units ref.) at 3 metre (9 feet) intervals.

.10 Joints in copper pipe shall be brazed. Brazing shall be carried out to the requirements of the local code and as per the Canadian copper & brass development association recommendations.

.9 Condensate Pipework:

.1 A condensate line shall be installed to each fan coil unit. This shall be installed and insulated all as per the standard specification. Minimum size of condensate pipes to be 25mm (1 inch) copper or plastic, insulated and pumped or by gravity from each fan coil/cassette, drains to run 1:80 min falls as indicated on drawings.

.10 Log Books

.1 Full commissioning Logs shall be supplied by the manufacturer’s local distributor. These shall be completed fully and included with the main Installation and Operation Manuals prior to hand over. In addition, copy pages shall be returned to the manufacturer at the following address in order that the installation is logged and warranty honored.

.11 Start-up air conditioning unit in accordance with manufacturer's start up instructions. Test controls and demonstrate compliance with requirements.

3.2 Delivery, Storage and Handling

.1 Unit shall be stored and handled according to the manufacturer's recommendation.

.2 The wired controller shall be shipped inside the carton with the indoor unit and able to withstand 40°C storage temperatures and 95% relative humidity.

3.3 Performance

.1 Performance shall be based on 19.4°C WB, 26.7°C DB for the indoor unit and 17.8°C WB, 29°C DB, for the outdoor unit.

.2 Refer to Air Conditioing Unit Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

.1 Electric baseboard.

.2 Related accessories and specialties.

1.2 Quality Assurance

.1 Provide electric baseboard units of one nationally represented manufacturer who is regularly engaged in the production of such units and who issues complete catalogue data on such products.

.2 Electric baseboard units shall be CSA approved and labeled.

1.3 Submittals

.1 Electric baseboard shop drawings shall include, at a minimum, the following information:

- .1 Radiation capacity/output
- .2 Enclosure type and length
- .3 Voltage
- .4 Wiring diagram

.2 Comply with the requirements of Division 01.

1.4 Closeout Submittals

.1 Provide maintenance data for incorporation into manual specified in Division 01.

1.5 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Division 01.

.2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Consultant.

.3 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.4 Dispose of corrugated cardboard, polystyrene, and plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

2. Products

2.1 Acceptable Manufacturers

.1 Electric Baseboard : Chromalox, Ouellet

2.2 General

.1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet of all baseboard and wall fin.

2.3 Electric Baseboard Heaters

.1 Steel cabinet with baked enamel finish. Sloped top louver grille with 6.4mm openings.

.2 Stainless steel element with aluminum fins.

.3 Controls:

.1 Unit mounted thermostat or as indicated on drawings.

.2 Integral over-temperature protection.

3. Execution

3.1 General

.1 Electric baseboard heaters to be supplied by Division 23 and installed by the Electrical Contractor.

.2 All units shall be capable of meeting or exceeding the scheduled capacities heating and air delivery. All unit dimensions for each model and size shall be considered maximums.

3.2 Performance

.1 Refer to Electric Heater Schedule on drawings.

END OF SECTION

1. General

1.1 Scope

.1 Electric cabinet unit heaters

.2 Related accessories and specialties

1.2 Quality Assurance

.1 Provide unit heaters of one nationally represented manufacturer who is regularly engaged in the production of such units and who issues complete catalogue data on such products.

.2 Unit heaters are to comply with provincial regulations and have CSA approval.

1.3 References

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.46, Electric Air-Heaters.

1.4 Submittals

.1 Unit heater shop drawings shall include, at a minimum, the following information:

.1 Heating capacities

.2 kW rating, voltage, phase

.3 Mounting methods

.4 Unit dimensions

.5 Cabinet material thicknesses

.6 Limitations

.7 Color and finish.

.8 Wiring diagrams

.2 Comply with the requirements of Division 01.

1.5 Closeout Submittals

.1 Provide operation and maintenance data for unit heaters for incorporation into manual specified in Division 01.

1.6 Waste Management and Disposal

.1 Separate and recycle waste materials in accordance with Division 01, and with Waste Reduction Workplan.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Consultant.

2. Products

2.1 Acceptable Manufacturers

.1 Electric Unit Heaters : Chromalox, Ouellet

2.2 General

.1 Factory apply baked primer coat on metal surfaces of enclosure or cabinet of unit heaters and cabinet unit heaters.

.2 All units shall be capable of meeting or exceeding the scheduled heating and air delivery capacities. All unit dimensions for each model and size shall be considered maximums.

.3 Electric heat to be in the blow-thru configuration.

2.3 Electric Cabinet Unit Heaters

.1 Steel cabinet with baked enamel finish. Inlet and outlet bar grilles on front face. Surface mounting arrangement.

.2 Two speed direct drive fan assembly.

.3 Steel sheathed heating elements, with corrosion protected steel fins.

.4 Controls:

  .1 Unit mounted thermostat.

  .2 Factory installed switching relays, fan delay switch, on-off switch, over-temperature protection and two position speed switch.

3. Execution

3.1 General

.1 Electric heaters to be supplied by Division 23 and installed by the Electrical Contractor.

.2 Install heaters as per manufacturer's instructions.

3.2 Unit Heater Installation

.1 Install unit heaters in locations indicated, securely fastened to the building structure.

3.3 Performance

.1 Refer to Electric Heater Schedule on drawings.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Complete and operational electrical system as required by the drawings and as herein specified.

1.2 Related Work

.1 General Requirements Division 01

.2 Specialities Division 10

.3 Equipment Division 11

.4 Mechanical Division 21, 22 and 23

1.3 Designation of Parties and Definition

.1 The following defines various items used within the Electrical Specification Division 26:

.1 ‘Engineer or Electrical Engineer’: This refers to Owner or Owner appointed representative.

.2 ‘Electrical Trade of Contractor’: The Contractor undertaking to do the electrical work described in the Electrical Specification and on the electrical drawings.

.3 ‘General Contractor or General Construction Trade’: The Contractor that has the agreement with the Owner for the construction of the project.

.4 ‘Mechanical Trade or Mechanical Contractor’: Sub-contractors undertaking to do the work described in the mechanical specifications and/or on the mechanical drawings.

.5 ‘Provide’: Means supply and install or supply labour and materials required for the installation of.

.6 ‘Approved Equal’: Items listed under Approved Manufacturer’s in specification or addendum that shall be included in base bid.

.7 ‘Concealed’: Where used in connection with the installation of electrical raceways and wiring, means that they are hidden from sight as in furred out spaces, ceiling spaces, etc.

.8 ‘Exposed’: Where used in connection with the installation of electrical raceways and wiring and electrical equipment, means that they are visible to persons within the building.

1.4 Drawings and Specifications

.1 The General Conditions, Supplementary Conditions and Division 01 are a part of this specification and shall apply to this Division.

.2 The intent of the drawings and specifications is to include all labour, products and services necessary for complete work, tested and ready for operation. Drawings and specifications are complementary each to the other and what is called for by one shall be binding as if called for by both.

.3 Symbols used to represent various electrical devices often occupy more space on the drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.

.4 These specifications and the drawings and specifications of all other divisions shall be considered as an integral part of the accompanying drawings. Any item or subject omitted from either the specifications or the drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.

.5 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work. Electrical drawings indicate general location and route to be followed by conduit and/or wire and do not show all structural and mechanical details. In some cases, conduit or wiring is not as shown on the plans or shown diagrammatically on schematic or riser diagrams. Conduit and wire to be installed to provide a complete operating job and to be installed physically to conserve headroom, furring spaces, etc.

.6 If discrepancies or omissions in the drawings or specifications are found, or if the intent or meaning is not clear, advise the Consultant for clarification before submitting tender.

.7 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.5 Quality Assurances

.1 Codes, Rules, Permits & Fees

.1 Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.

.2 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes.

.3 Quality of work specified and/or shown on the drawings shall not be reduced by the foregoing requirements.

.4 Give all required notices, submit drawings, obtain all permits, licenses and certificates and pay all fees required for this work.

.5 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Consultant.

.2 Standards of Workmanship

.1 Execute all work in a competent manner and to present an acceptable appearance when completed.

.2 Employ a competent supervisor (consistency is essential) and a sufficient number of licensed tradesmen to complete the Work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

1.6 Submittals

.1 Within 30 days of award of contract, the contractor shall submit a completed equipment procurement schedule which lists the manufacturer and model of equipment, indicating the projected ordering, shop drawing submittal date and delivery dates of all products to meet the required construction schedule.

.2 Submit samples as required where specified in Division 26.

.3 Prior to delivery of any products to job site and sufficiently in advance of requirements to allow ample time for checking, submit shop drawings for review as specified in Division 01. Submit shop drawings for all equipment as required in each section of this specification.

.4 Prior to submitting the shop drawings to the Consultant, the Contractor shall review the shop drawings to determine that the equipment complies with the requirements of the specifications and drawings.

.5 The term “shop drawing” means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.

Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross-references to design drawings and specifications.

Adjustments made on shop drawings by the Consultant are not intended to change the contract price. If adjustments affect the value of the work state such in writing to the Consultant prior to proceeding with the Work.

.6 Manufacture of products shall conform to revised shop drawings.

.7 Keep one complete set of shop drawings at job site during construction.

1.7 Record Drawings

.1 Refer to Section 01 77 00 Closeout Procedures – Operating and Maintenance Manuals and Record Drawings.

.2 The Contractor shall keep one complete set of white prints at the site office, including all addendums, change orders, site instructions, clarifications and revisions for the purpose of record drawings. As the work on site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions which deviate from the original contract documents. Record drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment. Include actual room names and numbers on these drawings.

.3 Prior to substantial performance, the contractor shall obtain CAD files of all electrical drawings, using AutoCAD, and use the services of a competent CAD operator to transfer all as-built information, including: Addendums, Change Orders, Clarifications, Revisions, Site Instructions and shop drawings. Upon completion, the contractor shall certify, in writing, that the as-built record drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.4 Contractor to forward letter of certification and as-built CAD drawings to the Consultant for final review. As-Built drawings to be submitted in the form of one set of CAD files on CD discs. Contractor is also to forward the hard copy red-lined as-built drawing to the consultant.

.5 The contractor may borrow copies of the electrical contract drawings on disc from the Consultant.

1.8 Operation and Maintenance Manuals

.1 Refer to Section 26 05 00 11 General Requirements.

.2 Provide hard copy and electronic copies of both Operating & Maintenance Manuals and Record Drawings.

.3 Within 30 days prior to substantial performance, the Contractor shall submit a draft copy of the proposed contents of each maintenance manual to the Consultant for review. Once the draft copy is approved, the Contractor will supply 4 copies in suitably labelled, hard back, D-Ring type commercial binders, each complete with an index and tabbed title sheets for each section. Final copies of manuals to be received by Consultant not less than 7 days prior to substantial performance.

.4 All maintenance manual data shall be printed on 8 1/2” x 11” heavy bond, indexed, tabbed, punched and bound in the binders. each manual shall have a title sheet which is labelled “Operation & Maintenance Manual”, and lists the Project name, Contractor’s & Consultant’s names, date submitted, and a Table of Contents for each volume. If a manual exceeds 75 mm in thickness, provide additional manuals as required.

.5 Provide an electronic version of complete manual.

.6 Each section of the manual shall contain the following information:

.1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.2 Descriptive and technical data.

.3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be manufacturer's data but may be typewritten instructions in simple language to guide the Owner in the proper operation and maintenance of his installation.)

.4 Servicing intervals recommended.

.5 A copy of all wiring diagrams complete with wire coding.

.6 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.

.7 Copy of data testing.

.8 Include type and accuracy of instruments used to obtain test data.

.9 Copy of final inspection certificate.

.10 Copy of the purchase order, showing equipment make and model numbers issued to the manufacturer complete with all addendums. All cost details may be hidden.

.11 Copy of all warranty certificates.

.12 Set of final reviewed Shop Drawings.

.13 Names, addresses, phone numbers and facsimile numbers of Contractor, Consultants, sub-contractors and suppliers used on the Work together with a specification reference of the portion of the Work they undertook.

1.9 Product Handling

.1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the Owner and to the approval of the Consultant.

.3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.

.4 Remove dirt, rubbish, grease, etc. resulting from this work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

1.10 Alternate and Separate Prices

.1 In accordance with the Instructions to Bidders, state on the Tender Form in the space provided, the amount to be added or deleted from the base bid tender amount for the use and installation of equipment as an alternate to those specified.

1.11 Guarantee

.1 Furnish a written guarantee to the Owner prior to final contract payment, which will be in effect for one year from the date of final acceptance of the complete work. Replace or repair at no cost to the Owner any defective material or workmanship except where, in the opinion of the Consultant, such defects are due to the misuse or neglect by the Owner.

.2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees, which cover a greater length of time.

.3 Note: Certain sections of this Electrical Specification are subject to the following warranty clause:

In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable to or chooses not to respond to a request by the owner for immediate emergency repair/replacement of the affected product, material or system, then the owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the owner or owner engaged forces in effecting the immediate repair/replacement.

1.12 Progress Claims

.1 Within thirty (30) days after award of contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the Consultant format. Subsequent requests for payment shall be documented accordingly.

1.13 Waste Management and Disposal

.1 Refer to Section 01 74 19 - Construction Waste Management

.2 Separate and recycle waste materials.

.3 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with the Waste Management Plan.

.4 Fold up metal banding, flatten and place in designated area for recycling.

.5 Ensure emptied containers are sealed and stored safely for disposal away from children.

.6 Place materials defined as hazardous or toxic waste in designated containers.

.7 Collect, package and store any salvaged or remaining materials such as wire, conduit, busbars, wireways, copper ground straps and other associated components for recycling and reuse.

2. PRODUCTS

2.1 Selected Products & Equivalents

.1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective products at their expense, and shall be responsible for any resulting delays and associated expenses, which result from defective products being rejected. Related materials shall be of the same manufacturer throughout the project.

.2 Products and materials referred to in the specifications by trade names, manufacturer's name and catalogue reference are those which shall be used as the basis for the Tender.

.3 The design has been based on the use of the specified product.

2.2 Alternative Products

.1 All product substitutions must be approved by the Consultant. Failure to obtain approval from the Consultant will result in the alternative product being rejected, in which case the Contractor shall provide an approved product at no additional cost to the owner.

.2 The Contractor shall assume full responsibility for ensuring that when providing alternative products or materials, all space, weight, connections, power and wiring requirements etc. are considered. Any costs incurred for additional components, changes to services, structural or space requirements, layouts and plans, etc. that may be necessary will be borne by the contractor.

.3 Suppliers to submit all requests for alternative product approval to the Consultant. Submissions must be received by the Consultant not less than seven (7) working days prior to the close of tenders. Submissions received after the “Cut-Off” date will not be reviewed.

All submissions, which are approved by the Consultant, shall be identified as “Approved Alternatives” in an Addendum. Alternative products not listed in the Addendum will be rejected.

.4 Approval of an alternate is not intended to change the original specifications unless specifically stated in the addenda. The submitter is responsible for all costs incurred by other trades as well as his own, to install the product/system in accordance with the contract documents.

.5 All submissions to be provided with technical data and whatever pertinent information that may be required by the Consultant to evaluate equivalency to the specified product. The responsibility to provide sufficient technical data with respect to submissions will remain solely with those making the submission.

2.3 Quality of Products

.1 All products provided shall be CSA Approved, Canadian Underwriters' Laboratory approved where applicable, and new, unless otherwise specified.

.2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Consultant.

2.4 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar products throughout the work.

2.5 Product Finishes

.1 Touch up all damaged painted finishes with matching lacquer, or, if required by the Consultant, completely repaint damaged surface.

2.6 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The warranty period shall not begin until the date of substantial performance of the work.

3. EXECUTION

3.1 Site Examination

.1 Examine the site of work and become familiar with all features and characteristics affecting this work before submitting tender.

.2 No additional compensation will be given for extra work due to existing conditions, which such examination should have disclosed.

.3 Report to the Consultant any unsatisfactory conditions, which may adversely affect the proper completion of this work.

3.2 Co-ordination with Other Divisions

.1 Examine the drawings and specifications of all divisions and become fully familiar with their work. Before commencing work, obtain a ruling from the Consultant if any conflict exists, otherwise no additional compensation will be made for any necessary adjustments.

.2 Lay out the work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural drawings take precedence over electrical drawings regarding locations of walls, doors and equipment.

.3 Do not cut structural members without approval of the Consultant.

.4 Coordinate with all Division installing equipment and services, and ensure that there are no conflicts.

.5 Install anchors, bolts, pipe sleeves, hanger inserts, etc. in ample time to prevent delays.

.6 Examine previously constructed work and notify the Consultant of any conditions, which prejudice the proper completion of this work. Commencement of this work without such notification shall constitute acceptance of other work.

3.3 Location of Outlets

.1 Electrical drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural drawings.

.2 Equipment locations shown on the drawings are approximate. Locations may be revised up to 3 meters to suit construction and equipment arrangements without additional cost to the Owner, provided that the Contractor is notified prior to the installation of the outlets, or equipment.

.3 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of manufacturers.

3.4 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminium, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Consultant and the ceiling installer, and approved clips or hangers are used.

3.5 Equipment Identification

.1 3 mm thick plastic lamacoid name plates, coloured face to match system colour, white core, mechanically attached with self tapping screws, 6 mm high lettering, to be attached to the front face of the following equipment:

.1 Starters, Contactors, Disconnects (Designation, voltage, load controlled)

.2 Colour code concealed conduits (including conduits above T-bar ceilings and under raised floor), concealed junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 metre intervals and at both side of transition through walls. All conduit, junction boxes and pull boxes in service rooms to be colour coded. Colour coding to be as follows:

SYSTEM	**MAJOR BAND**	**MAJOR BAND**
277/480V Normal	Bronze	
Standby Power	Voltage Color with ‘SB’ identification	White
120/208V Normal	Grey	
Fire Alarm System	Red	
Telephone	Lt. Green	
Building Alarm	Pink	
Commercial Television	Dk. Brown	
AV/TV Systems	Lt. Brown	
Clock System	Yellow	
Security Systems	Dk. Green	Lt. Brown
Door Intercom/Video	Purple	Yellow
Computers	Black	Yellow

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:
Equipment Grounding - Green
Neutral Conductor – White
277/480 Volt System 120/208 Volt System

Phase A - Orange	Phase A - Red
Phase B - Brown	Phase B - Black
Phase C - Yellow	Phase C - Blue

Fire Alarm System

Neutrals	White
Switch Legs	Phase Colour with White Tracer
Speaker Cct.	Blue with Yellow Tracer
Box Circuit	Black with Yellow Tracer
Annunciator	Brown with Yellow Tracer

.5 Low Voltage Wiring: per manufacturer's standard, i.e. CGE low voltage relay switching system.

.6 Install yellow plastic warning tape, 300 mm below grade, above all underground ducts.

.7 Provide permanent, corrosion resistant warning markers, suitable to the local inspection authority, imbedded in the surface of concrete slabs which are directly above high voltage cables and duct banks.

.8 All housekeeping receptacles to be labelled with ‘HK’ on the cover plate.

3.6 Wiring to Equipment Supplied by Others

.1 Equipment supplied by the Owner or under other Division will be moved to the installation site by others. However, the electrical connection to the equipment shall be done by this Division.

3.7 Instructions to Owner's Personnel

.1 Refer to Section 26 08 00 12 - Electrical Equipment and Systems Demonstration and Instruction.

3.8 Access Panels

.1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Consultant.

.2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Consultant.

3.9 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to center of device.

Receptacles in Mechanical Rooms	1000 mm
Receptacles & communication outlets	450 mm

Light Switches	1370 mm
Fire Alarm Manual Stations	1400 mm
Fire Alarm Horn/Strobes	2100 mm (300 mm below finished ceiling)
Clocks	2100 mm (300 mm below finished ceiling)
Television & Computer Outlets	450 mm
Intercom	1400 mm
Thermostats	1400 mm
Door Entry PushButtons	1400 mm
Wall mounted speakers	2100 mm (300 mm below finished ceiling)
Panelboards, starters and disconnects(to top of cover)	2000 mm
End of Line Resistors	2100 mm (300 mm below finished ceiling)
Outlets above Counters	175 mm above counter top or backsplash
Wall mounted Telephone outlets	1400 mm
Wall mounted Classroom Help Phone outlets	1100 mm

Note: Refer to Architectural Drawings for further mounting height details. Architectural Drawings take priority where conflicts exist with values indicated in this section.

3.10 Sealing of Wall and Floor Openings

.1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.

.2 Openings shall be sealed when all wiring entries shown on the drawings have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds, which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.11 Sprinkler Proof Equipment

.1 Electrical equipment installed where sprinklers are also installed shall be constructed so that water from the sprinkler heads shall not impair the effectiveness of the equipment. This will include, but not be limited to: Distribution Centres, Equipment Enclosures, Cabinets, Transformer enclosures, Panelboards.

.2 A separate and complete roof shall be provided on free-standing or surface mounted equipment. An overhang at the front, rear and sides shall prevent the entrance of water either at the top or through projecting face plates, meters, etc.

.3 Where conduits or cables are required to penetrate sprinkler proof roofs, rain tight connectors shall be used in conjunction with T & B 5260 Series sealing rings. Connectors shall be equal to:

.1 Rigid Conduit - T & B Bullet Hubs

.2 EMT - T & B 5123 Series (steel)

.3 Teck Cable - T & B 10460 Series

.4 Louvres shall be of the outdoor type.

3.12 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 4" above finished floor level.

.3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone RTV foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.13 Electrical Conduit in Slabs

.1 Electrical Trade Contractor to submit a drawing indicating the proposed layout for any electrical or other conduit to be cast into a structural slab or slab on grade.

.2 Locate conduit to be cast into a structural slab within the center third of the slab thickness only; arrange crossovers to ensure that all conduits are contained within the center third of the slab thickness. Maximum outside diameter of conduit is to be one quarter of the slab thickness.

.3 Do not displace reinforcing steel in order to place conduit; do not secure conduit in place by tying parallel to reinforcing bar.

.4 Place conduit with minimum spacing between parallel conduits equal to four (4) conduit diameters.

3.14 Temporary Power

.1 Provide grounded extension cords and temporary lights required for electrical work.

.2 Co-ordinate with General Contractor for obtaining temporary power service.

.3 If Owner's operations will be affected by any power outage required for this work, give adequate notice to the Owner and do not interrupt power until approval has been obtained.

.4 Give adequate notice to Contractor of any power outage required for this work. Schedule outages to provide least interference with other work.

3.15 Insulation Resistance Testing

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of Consultant.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for Consultant's review.

3.16 Load Balance

.1 Measure phase current to panelboards with normal loads operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of work, report listing phase and neutral currents on panel boards, dry-core transformers and motor control centers, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.17 Neutral Wiring

.1 Provide a separate white neutral conductor for each circuit in the offices. Unless specified otherwise.

3.18 Ground Wiring

.1 Provide a separate green ground conductor for each conduit run.

END OF SECTION

1. General

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 References, Codes and Standards

.1 CSA C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with ICEA requirements where permissible.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

1.4 Product Data

.1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

1.5 Warranty

.1 In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable or chooses not to respond to a request by the Owner for immediate emergency repair/replacement of the affected product, material or system, then the Owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the Owner engaged forces in effecting the immediate repair/replacement.

2. Products

2.1 Building Wires

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.

.3 Control circuits: No. 14 AWG or larger as required.

.4 Low voltage systems: size in accordance with manufacturers recommendations for proper operation of the equipment.

.5 Video cable: 75 ohm RG-6 100% shielded.

.6 AC90 (BX) cable may only be utilized for recessed tee bar fixture drops from ceiling mounted outlet boxes. Length of drops not to exceed 3.0 m (6'). Do not loop between fixtures.

.7 Fire alarm cable: FAS

2.2 Teck Cable

.1 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as indicated.

.2 Insulation:

.1 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.

.3 Inner jacket: polyvinyl chloride material.

.4 Armour: interlocking galvanized steel.

.5 Overall covering: thermoplastic polyvinyl chloride material.

.6 Fastenings:

.1 One hole zinc 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 at 600 mm centers.

.3 6 mm diameter threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight, approved for TECK cable.

2.3 Armoured Cables

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from aluminium strip.

.4 Type: ACWU90-PVC flame retardant jacket over thermoplastic armour meeting requirements of Vertical Tray Fire Test of CSA C22.2 No. 0.3 with maximum flame travel of 1.2 m.

2.4 Control Cables

.1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of armour of closely wound aluminium wire.

.2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with PVC insulation type.

3. Execution

3.1 General

.1 Minimum conductor size #12 AWG.

3.2 Installation of Building Wires

.1 Install wiring as follows:

  .1 In conduit systems in accordance with Section 26 05 33.

  .2 In cabletroughs in accordance with Section 26 05 36 12.

  .3 In wireways and auxiliary gutters in accordance with Section 26 05 36 13.

3.3 Installation of Teck Cable 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Lay cable in cabletroughs in accordance with Section 26 05 36 12.

.4 Terminate cables in accordance with Section 26 05 19 10 - Wire and Box Connectors - 0 - 1000 V.

3.4 Installation of Armoured Cables

.1 Group cables wherever possible.

.2 Lay cable in cabletroughs in accordance with Section 26 05 36 12.

.3 Terminate cables in accordance with Section 26 05 19 10 - Wire and Box Connectors - 0 - 1000 V.

.4 For ACWU cable, use non-magnetic connectors, ground armour and ground conductor at supply and only use non-metallic cable entrance plates. Support runs on steel or aluminium channels with spacers and clamps. Space cables to provide free air ampacity ratings unless otherwise shown.

3.5 Installation of Control Cables

.1 Install control cables in cable troughs.

.2 Ground control cable shield.

3.6 Workmanship

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Do not pull wires into incomplete conduit runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code. Submit data sheet with values measured.

.3 Do not install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e. for fire alarm system station circuits, etc.

.4 Provide sizes of conductors as shown on drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Consultant if problem is foreseen.

.5 Exercise care in stripping insulation from wire. Do not nick conductors.

.6 Conductor length for parallel feeders to be identical.

.7 Lace or clip groups of feeder conductors at all distribution centres, pull boxes, and termination points.

.8 All grounding conductor and straps to be copper. All ground conductors to have green insulation jacket except where specified to be bare copper.

3.7 Identification, Coding and Balancing

.1 For branch circuit wiring, follow identification system shown on the drawings and as specified in Section 26 05 00 11 - Electrical General Requirements.

.2 Connect single-phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" drawings.

.3 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two wraps of 3M #471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on site.

.5 For direct current wiring use red for positive and black for negative.

3.8 Testing

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by the cable manufacturer.

.2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Consultant.

END OF SECTION

1. General

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on drawings.

1.2 Special Codes

.1 Install and rate power cables in accordance with the Canadian Electrical Code requirements, or in accordance with IPCEA requirements where permissible.

1.3 References

.1 CSA C22.2 No. 65 Wire Connectors.

.2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).

1.4 Waste Management and Disposal

.1 Refer to section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.

.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.

2.2 Wire Connectors

.1 Use 3M “Scotchlock”, self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring, or approved equal.

.2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten - 32 x 3/8” machine bolts.

.3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.

.4 Thomas & Betts “KOPR-SHIELD” compound Series CP8 on all terminations for compression connectors.

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 C22.2 No. 65.

  .3 Install fixture type connectors and tighten. Replace insulating cap.

  .4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

.1 Select hand twist connectors for wire size and install tightly on conductors.

.2 Brush “KOPR-SHIELD” compound on terminations for compression connectors as recommended by the manufacturer.

.3 Install compression connectors using methods and tools recommended by manufacturer.

.4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Provide and connect all wiring devices for the complete installation.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Manufacturer

.1 Wiring devices to be of one manufacture throughout project.

.2 Manufacturers shall be Hubbell, Bryant or Arrow Hart.

2.2 Devices

.1 The catalogue numbers shown below are for the particular manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be specification grade minimum and wherever possible shall be of the same manufacture.

.2 Devices to be white with stainless steel, type 302 or 304 c/w No. 4 finish 1-mm thick coverplates in all but mechanical areas (and Electrical Rooms) unless noted otherwise. Use galvanized steel coverplates in mechanical areas (and Electrical Rooms) and for surface mounted devices. UPS power to be orange.

2.3 Coverplates

.1 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.2 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.3 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.4 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

.5 Use gasketted DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

.4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.

.5 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.

.6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.

.8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Consultant’s representative at the site. The above shall be used as a guide, but shall be subject to final verification prior to installation.

.10 Supply and install a separate neutral conductor for each branch circuit.

END OF SECTION

PART 1 - GENERAL

1.1 Description

.1 Provide ground fault protective system as indicated on the drawings.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

PART 2 - PRODUCTS

2.1 Materials

.1 Components comprising ground fault protective system to be of same manufacturer.

2.2 Breaker Type Ground Fault Interrupter

.1 Single or Two pole ground fault circuit interrupter for 15 – 30 A, 120/240 V, 1 phase circuit c/w test and reset facilities, or as indicated on drawings.

2.3 Ground Fault Protector Unit

.1 Self-contained with 20 A, 120 V circuit interrupter and duplex receptacle complete with:

- .1 Solid state ground sensing device.
- .2 Facility for testing and reset.
- .3 CSA Enclosure 1, flush mounted with stainless steel face plate.

PART 3 - EXECUTION

3.1 Installation

.1 Do not ground neutral on load side of ground fault relay.

.2 Pass phase conductors through zero sequence transformers.

.3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Arrange and pay for field testing of ground fault equipment by ground fault equipment manufacturer and contractor before commissioning service.

.3 Submit report of tests to Consultant and a certificate that system as installed meets criteria specified herein.

.4 Demonstrate simulated ground fault tests.

END OF SECTION

1. GENERAL

1.1 Description

.1 Connect to the existing building grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code, AB Building Code and the local Electrical Inspection Branch.

.2 The system is to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 All ground conductors shall be run in conduit.

1.2 References

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Equipment

.1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.

.2 All ground wires to be stranded copper TWH complete with a green jacket unless otherwise shown.

.3 Cable to pipe connectors to be made with Burndy GAR connectors.

.4 In the main electrical room, provide a copper ground bar complete with lugs suitable to terminate all ground cables.

.5 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.

3. Execution

3.1 General

.1 Install complete permanent, continuous grounding system including conductors, accessories. Where EMT is used, run ground wire in conduit. All connectors shall be installed in accordance with manufacturers requirements. All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.

.2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the Canadian Electrical Code. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green TWH. Use mechanical connectors for grounding connections to equipment provided with lugs.

.3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the Canadian Electrical Code.

.4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.5 All bolted connections must be accessible.

.6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.

.7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Canadian Electrical Code.

.8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per Canadian Electrical Code.

.9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy "Durium" or approved equal hardware.

.10 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.11 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.

.13 Protect exposed grounding conductors from mechanical injury.

.14 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.15 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.16 Soldered joints shall not be permitted.

.17 Connect building structural steel and metal siding to ground.

.18 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.19 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.20 Ground secondary service pedestals.

3.2 Electrodes

.1 Make connection to existing grounding system.

3.3 System and Circuit Grounding

.1 Install system and circuit grounding connections of the secondary 600V system.

3.4 Equipment Grounding

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

3.5 Grounding Bus

.1 Install copper grounding bus mounted on insulated supports on wall of electrical room.

.2 Ground items of electrical equipment in electrical room to ground bus with individual green insulated stranded copper connections size 3/0 AWG.

3.6 Communication Systems

.1 Install grounding connections for fire alarm, and communication systems as follows:

.1 Communications: make grounding system as shown on drawings.

.2 Fire alarm systems as indicated.

3.7 Field Quality Control

.1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Consultant and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

3.8 Communication Cable Tray

.1 Where a communication cable tray is installed, provide a #6 AWG ground conductor along the entire length of cable tray. Bond ground conductor to each section of tray. Home run ground conductor back to main building ground bus.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Supply and install all hangers and supports for the installation shown on the drawings and specified herein, as necessary to fasten electrical equipment securely.

1.2 Related Work

.1 Material and Equipment - Fastenings and supports. Section 26 05 29

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

  .1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the manufactures connecting components and fasteners for a complete system.

  .2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

  .1 Outdoors, wet locations: Hot dipped galvanized.

  .2 Indoors, dry locations: Galvanized when available, prime painted if not available.

  .3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

  .1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.

.3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 Non-Metallic Anchors

.1 Material: Plastic anchors for sheet metal screws.

.2 Manufacturer: Fischer.

2.4 Conduit Supports

.1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: “Caddy-Clips”.

.6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

.1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. Execution

3.1 General

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Consultants is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 meter span and 8 mm over a 2 meter span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer’s installation recommendations.

.6 Provide conduit rack with 25% spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.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 malleable iron or 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 Use plastic anchors for light loads only. Use metal anchors for all other loads.

.8 Shot driven pins may only be used with written approval of the structural engineer.

.9 Use round or pan head screws for fastening straps, boxes, etc.

.10 Do not support heavy loads from the bottom chord of open web steel joists.

.11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.

.12 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.

.13 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.15 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Consultant.

.17 Support lay-in T-bar ceiling light fixtures withT-bar.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data for cabinets in accordance with Section 26 05 00 11 Electrical General Requirements.

1.3 Warranty

.1 In the event of an emergency failure during the warranty period of any product(s), material(s) or system(s) installed under this Section, and the issuer of the warranty is unable or chooses not to respond to a request by the Owner for immediate emergency repair/replacement of the affected product, material or system, then the Owner reserves the right to recover, from the issuer of the warranty, all costs incurred by the Owner or Owner engaged forces in effecting the immediate repair/replacement.

1.4 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

  .1 Cast steel, Crouse Hinds, WBJ Series.

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

.1 Materials:

  .1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

  .1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

  .2 Use rolled edges for surface boxes.

.3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Cabinets

.1 Materials:

.1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.

.2 Locks: to match panelboards.

.3 Backplates: 1.5 mm steel backplate, one piece per cabinet, covering entire cabinet interior.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys.

2.4 Splitters

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

.1 Formed hinged cover suitable for locking in the 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 less than 400 AMP.

3. execution

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation. Maximum 30 m (100 feet) spacing.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code, as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

.2 Install terminal block where indicated.

.3 Splitters

.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.

.4 Identification

4. Provide equipment identification in accordance with Section 26 05 00 11- Electrical General Requirements.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

.1 CSA C22.1-Canadian Electrical Codes, Part 1.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

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 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

- .1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.
- .2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.

.2 Components:

- .1 Ceiling outlets, surface mounting, concealed:
  - .1 101 mm square, depth 54 mm, Iberville 52171 series
  - .2 119 mm square, depth 54 mm, Iberville 72171 series
- .2 Ceiling outlets, concealed mounting in concrete:
  - .1 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.

.2 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville 55171C.

.3 Wall boxes, concealed in concrete or masonry: for one and two gang applications shall be 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.

.4 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).

.5 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.

.6 Floor Outlets, concealed: Of a type adjustable after box secured, permanently watertight concrete type, sheet steel, T & B #1963.

.7 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

.8 For 277V switches: Non-interchangeable with 120V switches through special tapped mounting ears, with top and bottom knockouts only, Iberville #1110-HV Series or Iberville MBX-1-HV, or MBD-1-HV Series.

2.3 <u>Outlet Boxes for Rigid PVC Conduit</u>

.1 Materials:

.1 Rigid PVC boxes and fittings: Unplasticized PVC.

.2 Components:

.1 Floor boxes: Round with threaded hubs for threaded female connectors.

2.4 <u>Masonry Boxes</u>

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.5 <u>Concrete Boxes</u>

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 Concrete Floor Boxes

.1 Concrete tight electro-galvanized sheet steel floor boxes with brushed aluminum trim faceplate. Device mounting plate to accommodate short or long ear receptacles. Minimum depth: 28 mm for receptacles; 73 mm for communication equipment.

.2 Adjustable, watertight, concrete tight, cast floor boxes with openings drilled and tapped for 12 mm and 19 mm conduit. Minimum size: 73 mm deep.

.3 Floor box to allow matching carpet tile on box lid

.4 Openings cut to allow cables to exit floor box without box lid being raised.

.5 Modules shall allow a minimum of two duplex receptacles, one 3-port faceplate and one 2-port faceplate.

.6 Duplex receptacles to be contained within a grounded metallic box and grounded metallic faceplate

2.7 Conduit Boxes

.1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for any surface wiring of switches and receptacle.

2.8 Outlet Boxes for Non-Metallic Sheathed Cable

.1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.9 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

2.10 Service Fittings

.1 ‘High tension’ receptacle fitting made of 2 piece stainless steel with satin aluminum housing finish for 1 duplex receptacles. Bottom plate with two knockouts for centered of offset installation.

.2 Pedestal type ‘low tension’ fitting made of 2 piece stainless steel with satin aluminum housing finish to accommodate two amphenol jack connectors.

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 Install all outlets flush and surface mounted as required for the installation.

.6 Surface mount above suspended ceilings, or in unfinished areas.

.7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Use plaster rings to correct depth. Use 30 mm on concrete block.

.10 Do not use sectional boxes.

.11 Provide boxes sized as required by the Canadian Electrical Code.

.12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.13 Outlets installed in party walls to be offset by a minimum of one stud space.

.14 Ceiling outlet boxes shall be provided for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.

.15 Primary bushings in termination box for cable connection.

.16 Secondary bushings in termination box for bus duct connection.

.17 Control junction box.

.18 Stainless steel nameplate and connection diagram.

.19 Where outlet boxes penetrate throughout a fire or smoke separation, ensure that they are tightly fitted with non-combustible material to prevent passage of smoke or flame.

.20 No sectional or handy boxes to be installed.

4. **Back boxes for all low voltage systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the low voltage sections of these specifications.**

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Provide a complete system of conduit and fittings for installation of wiring.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Rigid Steel Conduit

.1 Galvanized with threaded joints and connections.

.2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222 or approved alternate.

.3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series or approved alternate.

.4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

.6 Minimum size to be 12 mm.

2.2 E.M.T. Conduit

.1 Fittings in dry locations: Steel or zinc set screw connectors with insulated throat. Steel or zinc set screw couplings.

.2 Fittings in wet locations: steel rain tite connectors with insulated throat. Steel rain tite couplings.

.3 Minimum size to be 12 mm.

2.3 Rigid P.V.C. Conduit

.1 Conduit: rigid non-metallic conduit of unplasticized polyvinyl chloride as manufactured C.G.E. "Sceptre" Schedule 40.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit manufacturer.

.3 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California's South Coast Air Quality Management District (SCAQMD) current.

2.4 Rigid PVC Duct

.1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride Type DB-2, conforming to CSA Standard manufactured by Canron Plastics Ltd.

.2 Accessories: Bell ends, couplings, adapters, bends and other fittings of same material as duct. Use solvent recommended by manufacturer. Horizontal, vertical and foundation spacers as manufactured by Pilgrim Products Ltd.

.3 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California's South Coast Air Quality Management District (SCAQMD) current.

2.5 Liquid-Tight Flexible Conduit

.1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

.3 Minimum size to be 12 mm.

2.6 Electrical Non-metallic Tubing (ENT)

.1 To CSA C22.2 N0. 227.1, Electrical Non-metallic Tubing

3. EXECUTION

3.1 Rigid Steel Conduit

Use as raceways for following applications:

.1 In all areas exposed to weather.

.2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.

.3 Three phase motor wiring (Teck cable may also be used for this application where shown on the drawings).

3.2 E.M.T. Conduit

.1 Use as raceways for following applications:

  .1 In surface and concealed areas or in poured concrete above ground level.

.2 It may not be used in damp locations, corrosive atmosphere, underground, outdoors, nor in areas exposed to mechanical damage.

3.3 E.N.T. Conduit

.1 Use as raceways for following applications:

.1 In concrete floor slabs and where not subject to mechanical injury either during or after construction. Minimum size shall be 25mm (1”)In surface and concealed areas or in poured concrete above ground level.

3.4 Rigid P.V.C. Conduit

.1 Use as raceways for following applications

.1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.

.2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.

.3 Rigid PVC conduit shall not be surface mounted.

.2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.

.3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.

.4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions.

.5 Bend rigid conduit in strict accordance with manufacturer's directions. Distorted bends will not be accepted.

3.5 Rigid PVC Duct

.1 Provide a separate green insulated copper ground wire in all ducts sized as required by the Code.

.2 Arrange ducts in a horizontal layer separated by plastic spacers to provide spacing between duct centres, as shown on the drawings.

.3 Support duct bank on plastic spacers 35 mm between ducts. Foundation spacers to maintain at least 76 mm clearance between ducts and exterior coverage.

.4 Make joints with tapered couplings to provide a secure watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use factory bends to provide bends of radius required.

.5 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.

.6 Terminate ducts with standard bell ends where ducts enter cable pits, junction boxes and building interiors.

.7 Cap ends of unused ducts with plug ends of same material as ducts.

.8 Seal all joints in ducts with solvent cement.

3.6 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

.1 At all motors, pipe mounted control devices, and other devices subject to movement or water.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.

.3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.7 Workmanship

.1 Install all conduit and wiring concealed, unless otherwise shown on the drawings. Do not recess conduit in columns, except as noted, without permission.

.2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric.

.3 Reuse existing concealed conduit in ceiling concrete slab as much as possible for feeding of power to lighting fixtures and to avoid surface run conduit as the existing slab will be exposed and there will be not dropped ceiling system.

.4 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.5 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Provide mechanical protection around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth it shall be protected by Polykin #940 tape. Extend taping 300 mm above finished grade.

.6 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. All joints are to be made up tight to ensure ground continuity. To prevent concrete entry, seal EMT set screw fittings with tape, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.

.7 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover.

.8 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required from structural engineer prior to installing conduits in slabs.

.9 At all recessed panels cap 2 - 25 mm and 4 - 19 mm empty conduits from panel into ceiling above future use.

.10 Provide Brady underground warning tapes 300 mm below grade above all underground conduits. Tape shall be yellow warning tape, 150 mm wide.

.11 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1000 mm beyond concrete and band conduit to dowel. The first 3 meter length of conduit extending from the structure to be Polykin wrapped rigid steel.

.12 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from shop drawings or detail drawings. Brace all stub-ups. Stub-ups shall be rigid steel.

.13 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per Canadian Electrical Code.

.14 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.

.15 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.16 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.

.17 Use insulated non-metallic bushings on all conduit terminations.

.18 Ensure electrical continuity in all conduit systems.

.19 All conduits shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.20 Install a 90 lb. test line in all conduits left empty by this contractor including those which others will pull cables, wires, etc.

.21 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.

.22 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant or approved equal.

.23 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Consultant.

.24 Where drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.25 Where conduit finish is damaged, repair or replace.

.26 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.

.27 All branch circuit wiring and home-runs to be a minimum of 19 mm and communication and data to be minimum 25 mm diameter unless otherwise stated.

.28 Where possible install conduit in equipment roof curbs. If roof penetrations are required, provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.

.29 Where panelboard branch circuit conduits are amalgamated, size shall not exceed 38 mm diameter.

.30 Where conduits pass through fire separations, seal with approved fire sealing compound.

.31 Maximum run of conduit shall not exceed 30 m. Provide pull boxes at a minimum of every 30 m.

.32 Allow no more than a maximum of two (2) 90 degree bends between pull boxes.

.33 All telecommunications conduits shall be bonded to ground.

.34 All conduit bends shall be sweep type bends with the inside radius not less than six (6) times the diameter for conduits 50 m and smaller and ten (10) times the diameter for conduits 65 mm and larger.

.35 All conduits stubbed into telecom rooms shall be turned up or down as appropriate and terminated at the edge of the plywood backboards. Terminate conduit stubs with an insulated grounding bushing and cap.

4. Provide a separate ground conductor in each conduit.

END OF SECTION

1. General

1.1 Description

.1 Provide a complete system of cable trays as shown on the drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Related Work

.1 Wire and connectors 1000V insulation and under. Section 26 05 19

.2 Fastenings and SupportsSection 26 05 29

1.3 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Indicate various types of cabletroughs with terminology used in Part 2.

1.4 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Cable Tray

.1 Wire Basket tray as indicated on drawings.

.2 Continuous, rigid, welded steel wire mesh cable management system

.3 Material may be carbon or stainless steel wire.

.4 Fittings to be field fabricated in accordance with manufacturer’s instructions

.5 Wire basket cable tray for all communications main and branch pathways to be 450mmW x 100mmD.

.6 Wire basket cable tray for all communications pathways to be cablofil (Flextray or approved equal).

.7 Provide drop out tray supports to protect communications cables when entering and exiting the wire basket cable tray.

.8 Provide EDRN fast splice to join 450mmW x 100mmD wire basket cable trays sections (three per each joining sections.)

.9 Provide EZT 90 kit for all hard 90º turn or tee installation.

.10 Provide GNDL grounding lug to ground each section of cable tray.

.11 Barriers where different systems are in the same cabletrough, or as indicated.

2.2 Supports

.1 Provide supports according to manufacturer's recommendations. Universal or L brackets may be used for wall installation, with a C bracket used for a ceiling installation.

.2 Provide hardened steel (HS) rod hangers, rod hanger clamps and accessories as required for suspended cable tray.

.3 Approved materials: Same as cable tray.

3. Execution

3.1 Installation

.1 Install complete cable tray system. Notify the Engineer of conditions that would adversely affect the installation of subsequent utilization of the system.

.2 Install at locations indicated on the drawings and in accordance with the manufacturer's instructions

.3 Wire Basket cable tray: to be installed by a certified installer by the manufacture. Cut wire basket cable tray in accordance with manufacturer's instructions. Use manufacturer's cutting tools to ensure integrity of cable tray.

.4 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.5 Fire stop all penetrations of fire barriers. Use EZ Path system where penetrating walls. Allow for EZ Path installation to full capacity of tray. Fire stop all conduits penetrating walls, floors and ceilings.

.6 Communications wire basket cable tray shall be grounded at both ends of every section of cable tray with #6 AWG insulated copper cable and connected to communications grounding bus bars only.

3.2 Cables in Cabletrough

.1 Install cables individually.

.2 Lay cables into the cable tray. Use rollers when necessary to pull cables.

.3 Identify cables every 30 m with nametags indicating the zone label.

.4 Only data, voice and media cables may be run in the cable trays. Power to be run in conduits. Upon leaving the cable basket, data and communication cables shall be run in J-supports unless otherwise noted.

4. **Provide grounding connections to the cable trays as per Canadian Electrical Code requirements.**

END OF SECTION

1. General

1.1 Description

.1 Supply and install wireways and auxiliary gutters and fittings as a means for flexible wiring system.

.2 All wireways and gutters to be two piece with removable cover to provide access to wiring.

.3 Wireways, auxiliary gutters and fittings are based on CSA CSS.2, No. 26.

1.2 Submittals

.1 Submit shop drawings in accordance with Section 26 05 00 11 - Electrical General Requirements.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Wireways

.1 Sheet steel with hinged cover to give uninterrupted access.

.2 Finish: based gray enamel.

.3 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

3. Execution

3.1 Installation

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, and connections to minimum.

.3 Install supports, elbows, tees, connectors, and fittings.

.4 Install barriers to separate different voltages or to separate different systems.

.5 Install gutter to full length of equipment.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 Provide complete system of underground ducts, fittings and turn-ups for the installation indicated on the drawings.

1.2 Related Work

.1 Excavation and backfilling: Division 2

.2 Concrete Work: Division 3

.3 Plumbing and Drainage: Division 3

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Rigid P.V.C. Duct

.1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride type EB-1 requiring concrete encasement, type DB-2 heavier wall for direct burial without concrete encasement, conforming to CSA Standard B196.1, manufactured by Canron Plastics Ltd, or IPEX inc. Nominal length 6 m plus or minus 12 mm with minimum wall thickness at any point of 3.0 mm.

.2 Accessories: Bell ends, couplings, reducers, plugs, caps, adaptors, bends and other fittings of same materials as duct. Use solvent weld compound as recommended by manufacturer. Horizontal, vertical and foundation spacers as manufactured by IPEX inc.

.3 Expansion Joints as required.

2.2 Cable Pulling Equipment

.1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.3 Duct Spacers

.1 Plastic spacers to suit installation shown, manufactured by IPEX. Minimum distance between conduits shall be 190mm centre-to-centre.

2.4 Markers

.1 Concrete type cable markers: As indicated, with words; “cable’, “joint’ or “conduit” impressed in top surface, with arrows to indicate change in direction of duct runs.

2.5 Solvents

.1 Solvent: Solvents to have Volatile Organic Compound (VOC) limits of less than 285g/L less water and less exempt compounds as per the State of California’s South Coast Air Quality Management District (SCAQMD) current edition.

3. Execution

.1 Install underground ducts for wiring systems as shown on the drawings and as per manufacturer’s instructions.

.2 Clean inside of duct before laying.

.3 Provide a separate green insulated copper ground wire in all ducts, even if not shown, except for conduits from a utility transformer into service entrance equipment. Use Canadian Electrical Code to size ground wire.

.4 Furnish minimum of 85% of total footage of each size in standard lengths of 6 meters or 3 meters. Remainder of each size may be furnished in random lengths, but not less than 1.5 meters.

.5 Arrange ducts in horizontal layers separated by plastic spacers to provide horizontal and vertical spacing between duct centres, as shown on drawings. Stack spacers vertically above each other and install in at least two groups per 10’ length of duct. Minimum distance between conduits shall be 190mm centre-to-centre.

.6 Support duct bank on plastic foundation spacers on same centre lines as tier separators. Foundation spacers to maintain at least 75 mm clearance between ducts and trench bottom or mud mat. Ensure full, even support every 1.5 m throughout duct length.

.7 Make joints with tapered couplings to provide a secure watertight connection. At locations where coupling is loosely fitted to produce a slight change of direction of the duct run, thoroughly waterproof joint with a coating of solvent compound. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use bender to provide bends of radius required.

.8 Make bell and spigot joints. Drive ducts together as recommended by manufacturer to produce a solid watertight connection. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use manufactured bends to provide bends of radius required.

.9 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.

.10 Use adaptors and connect duct to a 90-degree rigid, heavy-wall, steel conduit bend where conduit rises above ground.

.11 Terminate ducts with standard bell ends where ducts enter manholes, cable pits, junction boxes and building interiors.

.12 Pull through each duct steel, wooden or plastic mandrel not less than 300 mm long and of diameter 6 mm less than the internal diameter of duct, following by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling in cables.

.13 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.

.14 Plug ends of unused spare ducts with plugs of same material as ducts.

.15 Seal all joints in ducts with solvent cement.

.16 Install marker as required.

.17 Ensure lines and levels for underground ducts are set to obtain proper drainage, coverage, separation, etc. Ensure such conditions are met prior to proceeding with work.

.18 Construct duct runs to provide at least 750 mm from top of concrete encasement to finished surface above. Grade duct runs between manholes, vaults, cable pits and buildings to ensure proper drainage. Minimum slope shall be 75 mm per 30 m. Provide grades and slopes shown on drawings. Depths of cover shown on electrical drawings are minimum; greater depths may result from grading of ducts.

.19 Install ducts in accordance with additional requirements of utility or service company having jurisdiction.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Excavation and Backfilling: Division 02

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. PRODUCTS

2.1 Cable Protection

.1 38 x 140 mm planks pressure treated with clear copper napthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 Markers

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: “cable”, “joint” or “conduit” impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Cable Installation in Ducts

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables properly terminated, seal ends of cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.2 Markers

.1 Mark cable every 150 m along duct runs and changes in direction.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

3.3 <u>Field Quality Control</u>

.1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test.

  .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

  .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

  .1 Ensure that terminations and accessory equipment are disconnected.

  .2 Ground shields, ground wires, metallic armour and conductors not under test.

  .3 High Potential (Hipot) Testing.

    .1 Conduct hipot testing in accordance with manufacturer’s recommendations.

  .4 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.

4. **Remove and replace entire length of cable if cable fails to meet any of test criteria.**

END OF SECTION

1. GENERAL

1.1 Description

.1 Provide short circuit, coordination/protective and arc flash hazard analysis studies for the electrical system including all equipment specified herein and submit for review. A set of studies shall be submitted with the equipment shop drawings. If the electrical distribution system has either step-up or step-down transformers, default values for the transformer impedances shall be used unless the actual transformer impedances are available. The same shall be done for the utility transformer if the project is fed from a pad-mounted or overhead utility transformer. The electrical contractor shall provide a table with estimated conductor lengths for these studies. The electrical contractor shall obtain all utility fault data including MVAsc and X/R ratings for the study.

.2 For projects where the electrical distribution systems include either step-up or step down transformers or the project is fed from a utility pad-mounted transformer, the studies shall be resubmitted after the transformers are on-site. The actual transformer impedances shall be recorded and entered into the studies and a final set of studies shall be submitted for review complete with updated conductor lengths as previously submitted. Conductor lengths that are updated shall be flagged or highlighted. The new studies shall be done with the updated conductor lengths. Detailed arc flash hazard analysis labels shall be printed according to the requirements of CSA-Z462 (2015) and installed on all electrical equipment furnished with this contract after the engineer reviews the final studies. A sample label shall be furnished to the engineer for review with the second submission.

.3 Include the following:

- .1 Utility overcurrent and fault protection devices.
- .2 600V circuit breaker overcurrent, overload, and ground fault devices.
- .3 120/208V distribution panels, panelboards, motor control centres, emergency generators, switchgear and connecting feeder cables.
- .4 600V transformer damage curves, magnetizing currents for all transformers 150 kVA and larger.
- .5 Locked rotor currents, acceleration times and damage curves for motors 75 kW (100hp) and larger.
- .6 Any additional data necessary for successful completion of the studies as identified in IEEE STD 1584 – Guide for performing Arc Flash Hazard Calculations.

.4 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of circuit breaker tripping time or otherwise.

.5 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.

.6 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.

.7 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.

.8 Include a list of recommended settings for each relay and each circuit breaker that has adjustable settings.

.9 Include a list of recommended settings for each relay and each circuit breaker that has adjustable settings.

.10 Prepare a system single line diagram on which the resultant arc flash incident energy and hazard category are displayed.

1.2 Qualifications

.1 These studies shall be provided by the supplier of the distribution equipment.

1.3 Submittals

.1 Submit the first set of complete studies prior to submittal of shop drawing of electrical equipment for review by the engineer.

.2 Submit the second set of complete studies after the studies are updated with actual transformer impedances for review by the engineer along with a sample of the arc flash labels. Print labels according to ANSI – Z535.

.3 Calibration and verification to be conducted after the final studies have been reviewed by the engineer.

2. PRODUCTS

2.1 Tripping Devices

.1 Relay style, CT ratios, fuse and circuit breaker sizes and types have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of these studies and shall be included at no extra cost.

3. EXECUTION

3.1 Data

.1 Provide the main switchboard supplier with all relevant data for equipment not provided by that supplier.

3.2 Installation of Arc Flash Hazard Labels

.1 Clean the surfaces of the electrical equipment before installing the labels.
.2 Install the labels at the same height parallel to the edges of the electrical equipment.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Testing, Adjusting and Balancing of Electrical Equipment and Systems Section 26 08 00 11

.2 Electrical Equipment and Systems Demonstration and Instruction Section 26 08 00 12

1.2 Coordination

.1 Coordinate starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 26.

.2 Mechanical equipment and systems specified in Division 21, 22 and 23.

.3 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. products

(Not used)

3. execution

3.1 Energizing Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

.1 Verify phase rotation at motor control centres.

.2 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by others. Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

PART 1 - GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the Owner, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements — Section 26 05 00 11

.2 Starting of Electrical Systems and Equipment — Section 26 08 00 10

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Consultant for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 Applicable CSA, IEEE, IPCEA, EEMAC and ASTM standards

.2 If requirements of any of the foregoing conflict, notify Consultant before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

PART 2 - PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

PART 3 - EXECUTION

3.1 Main Switchboard

.1 Enclosure:

.1 Visually inspect.

.2 Torque all bus connections to manufacturer’s requirements and seal with red lacquer.

.3 Megger test main bus at 1000 V.

.4 Check phasing and continuity of horizontal and vertical bus. This includes phasing and phase rotation of two incoming services or supplies.

.2 Wiring Checks:

.1 Check all control, relaying and instrumentation wiring against vendor wiring schematics, three line diagrams and project specifications.

.2 Test each circuit for continuity using a buzzer or similar device.

.3 All current transformer circuits shall be injected, all voltage transformer circuits shall be powered at 120 Volts, all devices functioned and checked against control schematic diagram.

.4 Check polarity and verify phase relationships on all three phase metering circuits.

.5 Where errors are discovered and changes are required, mark up and note required corrective action on vendor prints.

.6 Function test secondary transfer schemes (if any) by simulated loss of incoming feeders to ensure proper operation.

.3 Instrumentation:

.1 Test and calibrate all meters in accordance with manufacturers bulletins.

.2 Check calibration on all ammeters using 5 Amp secondary injection test.

.3 Perform wiring checks as listed above.

.4 Breakers - Molded Case Breakers 150 Amp Frame and Larger:

.1 Visually inspect.

.2 Ductor test.

.3 Megger test.

.4 Mechanical function test.

.5 Set all units with adjustable magnetic trip units.

.6 Where solid state protection is provided with large breakers, test units as follows:

.1 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.

.2 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instruction.

.3 If manufacturer's tester is not available, use an approved relay tester unit with proper test data and test accessories.

.4 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of relay circuit to test trip operation.

.5 Check C/T and P/T ratios and compare to coordination data.

3.2 <u>Central Distribution Panels and Panel Boards</u>

.1 Enclosure:

.1 Visually inspect.

.2 Torque all bus connections to manufacturer’s specifications.

.2 Breakers - moulded Case Breakers 150 Amp Frame and Larger:

.1 Visually inspect.

.2 Ductor test.

.3 Megger test.

.4 Mechanical function test.

.5 Set all units with adjustable magnetic trip units.

.6 Where solid state protection is provided with large breakers, test units as follows:

.1 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.

.2 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instruction.

.3 If manufacturer's tester is not available, use an approved relay tester unit with the proper test data and test accessories.

.4 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of relay circuit to test trip operation.

.5 Check C/T and P/T ratios and compare to coordination data.

3.3 Fused and Unfused Disconnect Switches

.1 Visually inspect and clean.

.2 Ductor test across switch blade contact surfaces.

.3 Megger test.

.4 Mechanical function test.

3.4 Transformers - Under 225 Kva - Low Voltage

.1 Visual inspection of enclosure and all accessories.

.2 Torque test all bus connections and cable terminations.

.3 Megger test.

3.5 Motor Control Centres

.1 Visually inspect and clean.

.2 Remove starter covers to expose all bussing and confirm phasing continuity and rotation and identification of bussing.

.3 Torque test all bus connections and cable terminations to manufacturer's recommended levels.

.4 After bus connections have been torque tested, apply red lacquer to bolted connections.

.5 Megger test - phase to phase and phase to ground.

.6 Ductor test bus connections and starter/feeder assemblies as follows:

.1 Across starter assembly with disconnect and contactor contacts closed (from line side of disconnect to load side of contactor).

.2 From source connection at MCC to each starter disconnect line terminals to check MCC bussing and stab connections.

.7 Ensure all starters are properly labelled prior to testing.

3.6 Lighting

.1 Function test all light switches, luminaires, dimmers and lighting control equipment such as photo-cells, daylight sensors, occupancy sensors and time clock settings.

.2 Prior to energizing line and low voltage lighting control system, ensure manufacturer has checked all equipment and wiring for proper installation and termination. Manufacturer to check that all pre-set levels are set and operate as specified.

.3 Check operation of all emergency lighting units and exit lights.

.4 Record all settings for all lighting control devices such as time clock, sensors, etc.

3.7 Protective Relaying

.1 Set and test protective relays to settings provided in coordination study.

.2 The manufacturer's instructions for specific relay must always be used for information concerning connections, adjustments, repairs, timing and data.

.1 Inspect and test in accordance with manufacturer's most recent installation and maintenance brochure.

.2 Perform tests using manufacturer's relay test unit as applicable, with corresponding test instructions.

.3 If manufacturer's tester is not available, use an approved relay tester unit with proper test data and test accessories.

.4 Proof test each relay in its control circuit by simulated trip tests to ensure total and proper operation of breaker and relay trip circuit by injection of relay circuit to test the trip operation.

.5 Check C/T and P/T ratios and compare to coordination data.

3.8 Security System

.1 Prior to function testing of system, perform following in conjunction with manufacturer:

.1 Ensure all equipment is properly installed and all terminations completed.

.2 Prior to testing, ensure all programming is complete and software is performing correctly.

.3 Ensure all magnetic locks, door contacts and card readers are operational.

.2 Manufacturer shall function test system as follows:

.1 Door Supervision System:

.1 Check installation and operation of all door contacts and control panels, including automatic dialer, if specified.

.2 Confirm proper door labelling on all annunciators and main control.

.3 Record results on approved test forms.

.2 Card Access System

.4 Check installation of all equipment.

.5 Confirm operation of each door. Check door contacts, proper latching of magnetic locks, card operation and exit push buttons.

.6 Confirm correct labelling of doors on annunciators, CRT monitor and in programming.

.7 Confirm system programming and printer operation.

.8 Check remote alarming via automatic dialers.

.9 Check all interconnections with other systems.

.3 Record results on approved test report forms.

3.9 <u>Closed Circuit Television System</u>

.1 Prior to function testing system, perform following:

.1 Check installation of all cameras, monitors and control units and proper identification.

.2 Check operation of all camera pan/tilt controls and zoom lenses.

.3 Check clarity of pictures on all monitors at minimum and normal light levels.

.2 Manufacturer shall function test system as follows:

.1 For each camera, check operation of camera, zoom lens and pan/tilt control. For exterior camera's, check heaters and wipers.

.2 Check clarity of picture at monitor. Check monitors with camera's at minimum light levels.

.3 Check all interconnections with other systems.

.3 Record results on approved test report forms.

3.10 Communications Cabling

.1 Check installation of all equipment.

.2 Ensure all cables are properly identified at each end and correctly terminated prior to testing.

3.11 Testing of Wiring and Wiring Devices

.1 Test conductors at distribution centres and panelboards for insulation resistance to ground (megger test).

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation and circuitry.

3.12 Ground Resistance Testing

.1 Measure ground resistance of ground grids with earth test megger to verify compliance with CSA C22.2 No. 0.4-M1982 and Canadian Electrical Code.

3.13 Load Balance Testing

.1 Perform load tests with as many building loads on as possible prior to Interim Acceptance and three months after Practical Completion.

.2 Test load balance on all feeders at panel boards, distribution centres, motor control centres and lighting panelboards.

.3 If load unbalance exceeds 15%, reconnect circuits to balance loads. Revise panelboard directories and wiring identification accordingly.

3.14 Communication Cabling Testing

.1 Test all runs upon completion of permanent terminations as described in Section 27 10 05.

3.15 Harmonic Distortion Testing

.1 Perform harmonic distortion testing at following locations:

  .1 Main incoming service.

  .2 All 208 volt distribution centres, except car park distribution.

  .3 All primary and secondary of transformers.

.2 Harmonic tests to include phase and neutral currents and voltages for each order of harmonic up to 50th order.

.3 Allow for four hours or sampling at each location.

.4 Ensure all sources of harmonic distortion such as adjustable speed drives, Uninterruptable power supplies, computer and micro electronic equipment are energized before performing tests.

.5 Perform tests prior to interim acceptance.

.6 Certified test results sealed by professional engineer are to include harmonic distortion of each harmonic from 1 to 50 in graphic or tabular form. Results for main incoming service shall include harmonics coming in from utility and outgoing harmonics generated on facility power system.

.7 Recommended limits of distortion are to be based on ANSI/IEEE 519-1981 IEEE Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

3.16 Fire Alarm System Testing - General

.1 Refer to Section 26 05 00 11 - Electrical General Requirements.

.2 Consultant will be responsible for directing verification of fire alarm system installation in accordance with:

  .1 CAN/ULC-S537, Standard for Verification of Fire Alarm System Installations, and Requirements of authority having jurisdiction.

.3 Contractor shall be responsible for:

  .1 Performing prerequisites to verification procedure; and

  .2 Assisting and cooperating with Consultant in verification procedure

3.17 Fire Alarm System Testing - Prerequisites to Verification

.1 Prior to requesting verification by Consultant, do the following:

  .1 Inspect system to ensure that the following items are completely installed, connected and fully operational in accordance with requirements of the Contract Documents and Manufacturer's recommendations:

    .1 Complete fire alarm system including all components thereof

    .2 All fire suppression and detection devices

    .3 All smoke control equipment

    .4 All other auxiliary equipment connected to fire alarm system

  .2 Ensure that any subsequent work remaining to be performed on the above-noted items will not invalidate examinations and tests performed during verification procedures.

  .3 Ensure that operation and maintenance data has been submitted.

  .4 Ensure that spare parts and maintenance materials have been delivered.

.2 Submit written request to Consultant for verification, certifying that the above prerequisites have been fulfilled and specifying known exceptions in the form of a list of items to be completed, corrected or submitted.

.3 Consultant will, within two (2) weeks after receipt of written request:

.1 Proceed with verification, or

.2 Advise contractor that prerequisites are not adequately fulfilled

3.18 Fire Alarm System Testing - Verification

.1 The contractor and manufacturer shall assist and cooperate with Consultant in verification procedure. The contractor shall provide and pay for the following:

.1 Provide the following equipment:

.1 Voltmeter

.2 Sound pressure level meter

.3 Smoke generator or aerosol test smoke

.4 Four (4) portable communication devices

.5 Scaffolding and ladders

.2 Arrange and ensure that the following parties are present at all times during verification procedures:

.1 Electrical Subcontractor

.2 Fire alarm system manufacturer's representative

.3 Disassemble and reassemble system components

.4 Disconnect and reconnect wiring

.5 Perform required field adjustments

.6 Repair defective work and replace defective components

.7 Perform all work and tests on system required by verification procedure.

.2 Do not proceed with verification unless Consultant's representative responsible for directing verification procedure is present.

3.19 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

.2 Test voltage at all elevators.

.3 Test voltage at motor control centre.

.4 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Consultant.

3.20 Coordination and Short Circuit Study

.1 Provide a coordination/protective system study and short circuit study of all equipment.

3.21 Calibration and Verification

.1 Description

.1 Calibrate and verify the following equipment items supplied under this contract:

.1 Primary switchgear

.2 208V distribution equipment

.2 The calibration and Verification shall be carried out in the field after installation and connection of equipment, but prior to energization, in the presence of the Owner and the Consultant.

.3 Related Work in Other Sections

.1 Coordination and Short Circuit Study Section 26 05 73

.4 Submittals

.1 Submit details of all test procedures and instruments, together with technicians names, to the Consultant, prior to proceeding.

.2 Submit written verification report after installation is completed to reflect as-built conditions.

.5 Qualification

.1 Work shall be performed by a firm specializing in and with relevant experience in testing 600V switchgear and protective relaying.

.2 This firm shall also perform the final checkout and testing of the equipment specified in Item 3.13 of this Section.

.6 Products

.1 Not applicable.

.7 Calibration and Verification

.1 The calibration and verification shall be carried out in the following stages:

.1 Primary switchgear

.2 transformers

.3 208v distribution

.2 The Electrical Contractor shall advise well in advance when each stage is ready for the calibration and verification and he shall:

.1 Ensure that all equipment is installed, connected and cleaned inside and out.

.2 The electrical rooms are cleaned and are adequately illuminated and heated.

.3 Provide 120V convenience receptacles. (Minimum 4 or as shown on drawings).

.4 Provide one qualified electrician to assist in the calibration and verification.

.5 Provide all other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and overall coordination scheme. Field set each relay according to the recommended settings.

.4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the Coordination/Short Circuit Study. Submit a written report on this verification to the Consultant.

.5 Ensure all bus and cable connections are tightened to manufacturer's specifications.

.6 All relays are to be cleaned with dry, dust free compressed air.

END OF SECTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize Owner's operation and maintenance personnel with electrical systems and their operation and maintenance.

.2 Submit system sign off sheets for each system listed prior to substantial completion.

.3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the operating/maintenance manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/Owner Coordination

.1 Owner will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with Owner. Coordinate scheduling of sessions with Owner.

2. Products

(not applicable)

3. execution

3.1 Systems Demonstration and Instruction Seminars

.1 Provide demonstration and instruction seminars for the following equipment and systems identified. Include in demonstrations and instruction seminars, the information specified for each piece of equipment and system.

- .1 Normal Power Distribution (Below 750 V):
  - .1 Distribution Switchgear:
    - .1 Circuit breaker or disconnect switch operation.

.2 Protective features on breakers.

.3 Protective relaying - calibration and operation.

.4 Metering - calibration and operation.

.5 Safety procedures.

.6 Troubleshooting procedures.

.7 Visual maintenance inspections.

.8 Maintenance procedures.

.9 Testing requirements and procedures.

.10 Spare parts.

.2 Panelboards:

.1 Types and sizes of breakers.

.2 Spare capacity.

.3 Visual maintenance inspections.

.4 Maintenance procedures.

.5 Testing requirements and procedures.

.6 Spare parts.

.3 Branch Circuits:

.1 Power receptacle system.

.2 Miscellaneous wiring devices.

.3 Miscellaneous equipment.

.4 Power Zone Distribution System.

.4 Manual Motors Starters:

.1 Overload protection.

.2 Troubleshooting procedures.

.3 Maintenance requirements.

.4 Spare parts.

.5 Fire Alarm System:

.1 Alarm silence.

.2 Trouble conditions, alarm and silence.

.3 EVAC system.

.4 Annunciator and control panel operation.

.5 Mechanical systems control.

.6 Control panel module replacement.

.7 Alarm lamp replacement.

.8 Power supply.

.9 Sequence of operation under alarm conditions:

.1 First stage

.2 Central station tie-in

.3 Sprinkler system interface

.4 Fan shutdown

.5 Fire damper interface

.6 Elevator inter-connection

.10 Troubleshooting procedures.

.11 Maintenance requirements and procedures.

.12 Spare parts.

.6 Lighting:

.1 Interior/Exterior Lighting:

.1 Description of each luminaire with respect to lamp and ballast or any other special features:

.1 Troubleshooting procedures.

.2 Maintenance procedures.

.3 Re-lamp schedules.

.4 Spare parts.

.2 Lighting Controls:

.1 Line voltage switching.

.2 Dimmers.

.3 Occupancy sensors operation

.4 Time clock operation.

.5 Master control unit programming.

.6 Troubleshooting procedures.

.7 Maintenance procedures.

.8 Spare parts.

.7 Communication and Security Systems:

.1 Cable Television:

.1 Splitters and Amplifiers.

.2 Type of cable used.

.3 Troubleshooting procedures.

.4 Maintenance procedures.

.8 Door Supervision and Card Access System:

.1 Main console operation.

.2 Operation under alarm conditions.

.3 Alarm Lamp replacement.

.4 Troubleshooting procedures.

.5 Maintenance procedures.

.9 Closed Circuit Television System:

.1 Camera and monitors.

.2 Pan/Tilt Controls.

.3 Troubleshooting procedures.

.4 Maintenance procedures.

.2 Pump Protection Panels

.3 Mechanical Equipment Connections and Controls

.4 Grounding System

.5 Future Connection Points and Conduit Stubs

3.2 SITE TOURS

.1 Provide a series of walk through Contractor guided tours of facility to allow operators to familiarize themselves with the buildings electrical systems.

.2 Coordinate timing of tours with the Owner.

MOTOR SURVEY SHEET

Motor Name & Number ______
Manufacturer ______
H.P. ______ Max. Ambient ______ °C
R.P.M. ______ Service Factor ______
Volts ______ / ______ / ______ Insulation Class ______
AMPS ______ / ______ / ______ EEMAC Design ______
PHASE ______ Time Rating ______
Frame ______ Type ______
Serial #
Model # ______
Starter ______ Type ______

OPERATING CONDITIONS

Full Load Operating Amps ______ A ______ B ______ C
Full Load Operating Voltage ______ A-B ______ B-C ______ C-A
at Motor
Overload Relay Installed ______ Adjustable Setting ______ %
M.C.P. AMPS ______ Adjustable Setting ______
Acceleration Time (If over 5 seconds) ______
Reduced Voltage Starter Tap Setting ______
Reduced Voltage Starter Transition Time Setting ______
Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.
______
______

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: ____

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: ________________________________Dated: __________________________

General Contractor

Signed by: ________________________________Dated: __________________________

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The Consultant

Signed by: ________________________________Dated __________________________

The Owner's personnel have been instructed in the operation and maintenance of the above system:

The Owner

Signed by: ________________________________Dated __________________________

The above does not constitute a waiver of any of the requirements of the Contract Documents.

	ELECTRICAL CONTRACTOR	GENERAL CONTRACTOR
	______________________	______________________
Address:	______________________	______________________
	______________________	______________________
Phone:	______________________	______________________

END OF SECTION

1. General

1.1 Intent

.1 This section specifies electrical requirements relating to the commissioning of components, systems and integrated systems.

.2 Commissioning of building components and systems is the utmost importance to ensure the successful operation of this building. The building will not be considered complete until all systems have been demonstrated to work precisely in accordance with the Contract requirements.

.3 Responsibility for the satisfactory completion for the building and demonstration that the requirements of the commissioning are satisfied rests with the Contractor, who will employ and pay for any specialist supervision, inspection and testing as required to complete the work described.

.4 The Commissioning process consists of:

- .1 Component verifications.
- .2 System performance verification testing and demonstration.
- .3 Integrated system performance verification testing and demonstration.

.5 Except where otherwise specified, arrange and pay for the testing and related requirements.

.6 If test results do not conform with applicable requirements, repair, replace or adjust or balance components and systems. Repeat testing as necessary until results acceptable to the Commissioning Agent are achieved.

1.2 Related Divisions/Sections

.1 Division 01 – General Requirements

.2 Section 01 35 43 – Environmental Sensitive Procedures

.3 Section 01 91 00 – Commissioning

.4 Section 26 08 00 10 – Starting of Electrical Equipment and Systems

.5 Section 26 08 00 11 – Testing, Adjusting and Balancing of Electrical Equipment and Systems

.6 Section 26 08 00 12 – Electrical Equipment and Systems Demonstration and Instruction.

1.3 Related Documents

.1 Owner’s Commissioning Plan

1.4 Commissioning Process

.1 The Commissioning process will consist of the following:

.1 **Phase 1 – System Readiness (Installation Verification):** pre-start checks of all equipment, all electrical and controls connections completed, chemical treatment and lubrication of equipment completed, control point-to-point checkout complete, installation observation checks completed and deficiencies corrected prior to Phase 2. The Engineer of Record will perform periodic inspections of the equipment installation to ensure compliance with the Bid Documents. The Commissioning Agent will also inspect the equipment and systems to verify proper installation.

.2 **Phase 2 – System Startup, Testing & Balancing (Startup and Checkout, Sampling):** The contractor and contractor's test engineer will perform system startup and checkout of the equipment. This includes testing operation of individual components and systems, initial tests of sequence of operation and corrections or adjustments, perform balancing of each component and review with respect to specified performance, ensure equipment is fully operational prior to Phase 3. The Commissioning Agent will randomly sample the contractor results to verify the startup and checkout is completed, including sampling of 10% of control points to verify point-to-point checkout.

.3 **Phase 3 – System Verification (Functional Testing):** The Contractor's Test Engineer shall prepare written, repeatable, test procedures for equipment and systems. These test procedures shall describe systematic test procedures, expected system response, acceptance criteria, actual system response or findings, and follow-up discussion. The test procedures will include verification of control sequences under each mode of operation including start-up, shutdown, unoccupied and manual modes, modulation of equipment from no-load to full-load conditions, power failure mode, alarms, staging, backup, and interlocks. Seasonal testing will be performed with heating and cooling systems at near design conditions. All test procedures shall be approved by the Commissioning Agent.

.4 **Phase 4 – Demonstration & Instruction (Training & O&M Manuals):** The Commissioning Agent will compile written verification that training was completed on all commissioned systems and equipment. Training will be performed by qualified individuals only.

1.5 Verifications & Reporting

.1 General:

.1 Submit completed verification and test reports after inspections and/or test are performed.

.2 Record all data gathered on site on approved verification forms.

.3 Provide the Commissioning Agent with original of each completed verification form.

.4 Maintain one photocopy on site of all data taken during commissioning.

.5 Maintain one copy of all final starting, testing, balancing and adjusting reports on site up to interim acceptance of the work for reference purposes.

.6 All final verification forms are to be typewritten.

.7 Submit to Commissioning Agent for approval.

.8 Make corrections and re-submit as requested by Commissioning Agent.

1.6 Schedule

.1 Prior to starting and testing of components and systems, prepare a schedule for the required testing.

.2 Provide sufficient notice (minimum 14 calendar days) prior to commencing tests.

.3 Commissioning Agent may witness all or any portion of the component testing.

.4 The Commissioning Agent shall review, verify and approve all completed component forms.

.5 The Commissioning Agent shall witness all system and integrated system test performed by the Contractor.

.6 Contractor is to be present for all tests.

.7 Unless otherwise specified in writing by the Commissioning Agent all testing and related requirements specified herein will be performed prior to issue of the Interim Certificate of Completion.

1.7 Coordination

.1 Coordinate all sub-trades, manufacturers, suppliers and other specialists as required to ensure all phases of work shall be properly organized prior to commencement of each particular testing procedure. Establish all necessary manpower requirements.

.2 Where any components or systems require testing prior to starting, ensure that such work has been completed and approved prior to starting of these components and systems.

1.8 Season Constraints

.1 Notwithstanding all-inclusive requirements specified in the Section, additional separate cycles of Commissioning may be necessitated at a later time for components and systems whose full operation is dependent on seasonal conditions.

.2 The Contractor will conduct System or Integrated System tests which the Commissioning Agent determines must be deferred because of their dependence on seasonal conditions. The Commissioning Agent will witness and approve deferred tests. The completed and approved tests will incorporated into the final commissioning report by the Contractor.

1.9 Commissioning Meetings

.1 Provide the appropriate representation at the scheduled commissioning meetings.

1.10 Quality Assurance

.1 All starting, testing, adjusting and balancing procedures shall be in accordance with:

.1 These contract documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 Applicable portions of CSA, IEEE, IPCEA, EEMAC, NEMA and ASTM standards.

.2 Personnel involved in starting, testing, adjusting and balancing procedures shall have experience in Division 26 Component and Systems Testing and shall be able to interpret results of readings and tests and report state of systems in a clear and concise manner.

.3 If the requirements of this or any related section conflict, notify Commissioning Agent before proceeding with tests and obtain written clarification.

1.11 Manufacturer's Reports

.1 Arrange for manufacturer to submit copies of all production test records for production tests required by these specifications prior to shipping.

.2 Arrange for manufacturer to submit brief step-by-step description of entire starting procedure to allow Commissioning Agent to repeat starting at any time.

1.12 Manufacturer's Starting Recommendations

.1 Prior to starting components or systems, obtain and review manufacturer's installation, operation and starting instructions. Read in conjunction with procedures specified in Section 26 08 00 10.

.2 Use manufacturer's and supplier's starting personnel where required to maintain validity of manufacturer's warranty. Confirm with manufacturer that all testing specified in these specifications will not void any warranties.

.3 Compare installation to manufacturer's published data and record discrepancies. Modify procedures detrimental to components performance prior to starting equipment.

1.13 Manufacturer's Service on Site

.1 Arrange and pay for qualified manufacturer's representatives to supervise Division 26 Component and Systems Testing as required in the referenced sections.

.2 Manufacturer's personnel shall be experienced in the design and operation of components and systems being started and have the ability to interpret results of readings and tests and report results in a logical fashion.

1.14 Presiding Authorities

.1 Starting procedures defined in this section may duplicate verification conducted by presiding authorities. Witness procedures in a manner that avoids unnecessary duplication of tests.

.2 Obtain certificates of approval, acceptance and comply with rules and regulation of authorities having jurisdiction. Provide originals of all certificates to the engineer.

1.15 Correction of Deficiencies

.1 Identify, resolve, and correct all contract deficiencies found during commissioning.

1.16 Compliance with Defined

.1 Failure to follow the specified instructions defined herein pertaining to correct starting procedures may result in re-evaluation of components:

- .1 At the Commissioning Agent’s decision, components will be re-evaluated.
- .2 Re-evaluation of components will be performed by independent testing agencies selected by the Commissioning Agent at the Contractor’s expense.
- .3 Should the re-evaluation reveal that components were not started in accordance with specified requirements, components may be rejected.
- .4 Remove rejected components from the site and replace.
- .5 Replacement components shall also be subject to:
  - .1 Full starting procedures, using same procedures specified on the originally installed components.
  - .2 The Commissioning Agent’s decision for re-evaluation the replacement components to assure correct starting procedures.

1.17 Testing Conducted by Commissioning Agent

.1 The Commissioning Agent may randomly select components, systems, and integrated systems to be re-tested.

.2 Testing of any component, system or integrated system by the Commissioning Agent does not reduce the Contractor's obligations in regard to the specified testing and startup procedures.

.3 The Commissioning Agent will be responsible for the direct costs of any Commissioning Agent’s testing except costs toward the Contractor’s support.

.4 Without cost, the Contractor will support testing by:

.1 Making all test equipment and instrumentation available to the Commissioning Agent.

.2 Operating the appropriate components, systems and integrated systems.

.5 Any test duplicated by the Commissioning Agent will be conducted under the same requirements specified to the Contractor.

.6 The Contractor may witness any test procedure or inspection conducted by the Commissioning Agent.

.7 Should any component or system fail under test or inspection performed by the Commissioning Agent:

.1 The Contractor will correct the deficiency and retest to the satisfaction of the Commissioning Agent.

.2 The cost of correction of deficiencies and testing shall be the Contractor's expense.

1.18 Specialty Agencies and Testing Laboratories

.1 All specialty agencies and testing laboratories shall be pre-approved by the Commissioning Agent.

.1 Pre-approval by the Commissioning Agent shall be based on the specialty agency or testing laboratory having acceptable facilities and qualifications.

.2 All reports generated by special testing agencies or testing laboratories shall be submitted by the Contractor to the Commissioning Agent.

2. Products

2.1 Contractor Testing Instruments

.1 Provide two-way radios, ladders and other equipment as required to complete the program and as outlined in the specification.

.2 Provide all safety equipment required for personnel involved in the starting, testing, adjusting and balancing program.

.3 Provide a list of equipment and instruments which will be used in starting, testing, adjusting and balancing of electrical equipment for approval and review by the Engineer.

.4 Use instruments supplied or calibrated by approved laboratory or manufacturer. Show the Engineer the current calibration certificate for each instrument to be used. Provide a copy of the calibration certificates with test reports.

3. Execution

3.1 General

.1 Contractor and manufacturer startup and proving to be carried out in accordance with the respective Section.

3.2 Components Verifications

.1 The component verification forms shall be completed as follows:
   - .1 The ‘Shop Drawing’ information shall be completed by the Contractor.
   - .2 The ‘Installed and inspected’ information shall be completed by the Contractor.
   - .3 All Component verification forms will be subject to review, verification and approval by the Commissioning Agent.

3.3 Component Verification Forms

.1 For the purpose of this specification the following component verification forms are available from the Commissioning Agent.
   - .1 E01 – Service Entrance Board Test Report
   - .2 E02 – Panel Board Test Report
   - .3 E03 – Moulded Case Circuit Breaker Test Report
   - .4 E04 – Interior Receptacles Test Report
   - .5 E05 – Exterior Receptacles Test Report
   - .6 E07 – Motor and Starter Test Report
   - .7 E08 – Disconnect Switch Test Report
   - .8 E10 – Interior Lighting Test Report
   - .9 E11 – Exterior Lighting Test Report
   - .10 E12 – Exit Lights Test Report
   - .11 E13 – Low Voltage Lighting Devices Test Report
   - .12 E14 – Low Voltage Relay Cabinet Test Report
   - .13 E16 – Power Surge Protector Test Report
   - .14 E19 – Telephone and Data Rack, Patch Panel and Bix Block Test Report
   - .15 E20 – Telephone and Data Outlet Test Report
   - .16 E21 – Security System Component Test Report
   - .17 E22 – Fire Alarm Device Test Report

3.4 System Performance Verification Testing

.1 All Contractor and manufacturer startup and proving tests are to be completed and approved by the Commissioning Agent prior to conducting the defined system performance verification tests.

.2 All component verifications related to a given system shall be completed and approved prior to conducting the defined system performance verification test.

.3 The Contractor will complete the contractor verification portion of the system performance verification test prior to notifying the Commissioning Agent that the system is ready for verification.

.4 System performance verification test verification forms are provided by the Contractor for information and convenience and will not relieve the Contractor of responsibility for verification of systems not included.

.5 System performance verification testing shall be scheduled and conducted by the Contractor.

.6 System performance verification test per the verification forms will be conducted in the presence of the Commissioning Agent.

3.5 System Performance Verification Test Forms

.1 For the purposes of this specification the following system Performance Verification Test Forms are available from the Commissioning Agent:

- .1 E31 – Low Voltage Control System Startup Report
- .2 E32 – Data and Voice System Startup Report
- .3 E33 – Security System/Card Access System Startup Report
- .4 E34 – Fire Alarm System Start-up Report

3.6 Integrated System Performance Testing

.1 Participate in the integrated system Performance Verification Testing.

END OF SECTION

1. General

1.1 Related Sections

.1 Common Work Results for Electrical Section 26 05 00

.2 Identification for Electrical Systems Section 26 05 53

.3 Electrical Starting and Testing - General Requirements Section 26 08 00.10

.4 Grounding and Bonding for Electrical Systems Section 26 05 26

.5 Electrical Power Monitoring and Control Section 26 09 13

.6 Transient Voltage Suppression Section 26 43 00

1.2 System

.1 This section includes the main distribution centre construction, operation and specification requirements.

1.3 Reference Standards

.1 Details indicate components required and general arrangement, busbar spacings, clearances, busbar mountings, cable spaces, etc., to be in accordance with CSA standards, the Consultant and electrical inspection authority.

.2 CSA C22.2 No. 29-M1983 - Panelboard and panelboard enclosures.

.3 CSA C22.2 No. 76-M1981 - Splitters

1.4 Coordination With Other Work

.1 Co-ordinate with the equipment supplier a composite system for all protection circuits.

2. Products

2.1 Main Distribution Centre

.1 Main distribution centre: 120/208V, 3 Phase, 4 wire, 600A solid neutral design. Components as indicated on drawings and listed herein. Drawing shows general arrangement only. All busbar clearances, busbar spacings, etc., to be in strict accordance with CSA requirements. Entire assembly and all components to be CSA approved. Distribution centre to be barriered into compartments with suitable buspads between sections.

.2 Main distribution centre to be totally enclosed in sheet metal panels with front panels of dish or formed type construction. Internal barriers to be provided to separate the various components with suitable bushed ports or buspads in barriers.

.3 The main busbar connections and risers to be clearly identified with phase markings A. B and C throughout. Viewing distribution centre from the rear, the right-hand circuit breaker terminals connected to phase A, the centre terminals to phase B and the left-hand terminals to phase C.

.4 Distribution centre bussing to be rectangular section Copper 600A capacity. All joints to be tinplated and securely bolted. All bussing to be braced to withstand 50 kA (minimum) symmetrical at 208V.

.5 Provide bus stabs at rear of main breaker section complete with busbar drillings and cable connectors to accept single conductor copper RW90 X-link insulated conductors.

.6 Provide drip shield sprinkler protection.

.7 Provide lock-off mechanism for each breaker and breaker space.

.8 Main Breaker: 3 pole moulded case automatic air circuit breaker complete with an adjustable electrical trip circuit, 208 V, 600 A frame size, 400 A trip with not less than 50 kA symmetrical interrupting capacity at 208 V. The main circuit breaker shall be rated for 100% loading. Breaker to be complete with handle projecting through front cover and lock-off facility. Line terminals of main breaker to have lugs as required to receive incoming service conductors. From load terminals of the main breaker full capacity bus connection to be made to the CTs and feeder breaker section. Main breaker section to be large enough to allow easy bending of feeder cables into position.

.9 Main circuit breaker to have a minimum of 50 kA instantaneous override. Main breaker assembly shall be CSA approved as a main service entrance device, circuit breaker trip unit and sensors to be integral with the circuit breaker. Protective control unit to be powered from the protected circuit, and shall be microprocessor based fully adjustable RMS type unit having long-time, short time, instantaneous, and ground fault adjustable elements.

.10 CT section to be of a size required by the supply authority complete with hinged cover with provision for a utility padlock. Provide mounting facilities for supply authority’s CTs and make all primary connections from the main breaker to the CTs and feeder breaker section.

.11 Main distribution centre to come complete with a Transient Voltage Surge Suppressor (TVSS) rated for service entrance protection. The TVSS to be integral with the distribution centre and bus bar connected.

2.2 <u>Feeder Breaker Section</u>

.1 Feeder breaker section to consist of an assembly of 3 pole moulded case automatic air circuit breakers with interrupting capacity of not less than 50 kA symmetrical at 208 V of the frame size and number of poles and trip ratings as listed in the schedule at the end of this section of the specifications. Where space only is called for, provide all busbar drillings, mounting brackets, filler pieces, etc., to facilitate the installation of feature breakers. Provide provision to lock off all feeder breakers.

2.3 Trim

.1 Sectionalized.

.2 Cover around all circuit breakers held on by machine screws.

.3 Hinged cover with provisions for utility padlock over metering transformer section.

3. Execution

3.1 Installation

.1 Install main distribution centre on 102 mm concrete housekeeping pad. All concrete work by Division 3.

.2 Coordinate main distribution centre delivery and installation with building construction.

.3 Where conduits are installed in the top or sides of the distribution centre waterproof fittings shall be utilized.

3.2 Main Distribution Centre Nametags

.1 Provide lamicoid nametags indicating name of building, name of electrical consultant, name of manufacturer, contractor and data installed.

.2 Provide lamicoid nametags for all breakers. Lettering on nametags to be not less than 9.5 mm high.

3.3 Shop Drawings

.1 Full shop drawings of the distribution equipment to be submitted to the Consultant for review prior to manufacture of equipment specified. Equipment to comply with intended requirements of this specification. Equipment drawings rejected at discretion of the Consultant to be altered so as to comply with requirements and intent of these specifications and to be resubmitted for checking without undue delay.

END OF SECTION

1. general

1.1 Description

.1 Provide disconnect switches for 120/208 volt distribution as indicated on the drawings, as manufactured by Cutler Hammer, Schnieder or Square D.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. products

2.1 Disconnect Switches

.1 Ratings: 240 volts for 120/208 volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: One primer coat and one finish coat on all metal surfaces, colours as per Section 26 05 00 11 - Electrical General Requirements.

.4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "Off" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

.1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limiting type. In addition, fuses feeding motors to be of the time delay type. Provide one full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. execution

3.1 Disconnect Switches

.1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped, mount in uniform arrangement.

.2 Wiring: Connect line and load cable to all switches.

.3 Fuse Rating: Install so that rating is visible.

.4 Identification: Provide lamacoid plate in accordance with Section 26 05 00 11 - Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

- .1 Door Controller
- .2 120/208 Volts
- .3 Fed from PPA

END OF SECTION

PART 1 - GENERAL

1.1 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Ground fault protective equipment: product of one manufacturer.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

PART 2 - PRODUCTS

2.1 Equipment

.1 Provide ground fault protection on the 120/208V, 4 wire, 3 phase main switchboard.

.2 Ground fault unit to contain:

- .1 Ground sensing relay.
- .2 Ammeter to indicate ground current value.
- .3 Three position sensitivity control switch to select value of leakage current at which relay will operate.
- .4 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
- .5 Switch:
    - .1 SPDT contacts for alarm and trip.
    - .2 Mechanical target indication.
    - .3 Manually reset.
- .6 Reset button for contacts and target.
- .7 Suitable for panel mounting.

.3 Zero sequence transformer rectangular type.

.4 Neutral:

- .1 Use an artificial neutral and grounding resistor
- .2 Use neutral ground resistor unit.

2.2 Fabrication

.1 Install following components in equipment specified in other Sections and as indicated.

.1 Zero sequence transformer

.2 Ground fault relay

.3 Ground resistor unit.

PART 3 - EXECUTION

3.1 Installation

.1 Do not ground neutral on load side of sensor.

.2 Install phase conductors including neutral through zero sequence transformer.

.3 Install ground fault protection system.

.4 Make connections as indicated and in accordance with manufacturer's recommendations.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Arrange and pay for field testing of ground fault equipment before commissioning service.

.3 Submit report of tests to Consultant and certificate that system as installed meets criteria specified.

.4 Demonstrate simulated ground fault tests.

END OF SECTION

1. General

1.1 Related Work

.1 Rough Carpentry - Fire Rated Plywood Backboard Division 26

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Panelboards

.1 Panelboards: product of one manufacturer.

  .1 Install circuit breakers in panelboards before shipment.

  .2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 208V panelboards: bus and breakers rated interrupting capacity as indicated on drawings.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Trim with concealed front bolts and hinges.

.9 Trim and door finish: baked grey enamel.

2.2 Custom Built Panelboard Assemblies

.1 Double stack panels as indicated.

.2 Contactors in mains as indicated.

.3 Feed through lugs as indicated.

.4 Isolated ground bus.

2.3 Breakers

.1 Breakers: to Section 26 24 16 10 **-** Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.4 Lock-on devices for 10% of 15 to 30A breakers installed as indicated. Turn over unused lock-on devices to Owner.

2.4 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

3. **Execution**

3.1 Installation

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 26 05 00 11 - Electrical General Requirements or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

1. GENERAL

1.1 Description

.1 This section covers the providing and installation of distribution panelboards.

1.2 Related Documents

.1 All sections of the Bidding Requirements, contract Conditions and Division 1 are part of this section.

.2 Applicable sections of Division 16 are part of this section of the Specifications.

2. PRODUCTS

2.1 Panelboards, Circuit Breaker Type, 208/120 Volt, 3 Phase 4 Wire

.1 Manufacturers: Square D, Siemens, General Electric, or Cutler-Hammer

.2 Shall be dead front type with flush or surface mounted steel cabinet as required and an internal assembly of circuit breakers. Trims shall have hinged and locked doors with glass or heavy plastic covered circuit directories. All locks shall be keyed alike. Boxes shall be galvanized, and front assembly shall be painted with a prime and a finish coat of manufacturer=s standard finish. Panels shall have 3 phase, 4 Wire, solid neutral mains of capacities indicated on the Drawings with main lugs or main circuit breaker as required.

.3 Panelboards shall have suitable gutter space to accommodate separate neutrals conductors for all branch circuits.

.4 Circuit breakers shall be molded plastic case type, quick-make, quick-break, with trip free common operating handle, position indication and common trip from thermal-magnetic trip device. Trip ratings shall be as indicated on the Drawings and minimum interrupting capacity shall be 22,000 RMS symmetrical amperes at 240 volts.

2.2 Distribution Switchboards

.1 Manufacturers: Square D, Siemens, General Electric, or Cutler-Hammer

.2 Ratings

.1 The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current 65,000 amperes symmetrical at 240 volts.

.2 The switchboard shall operate at 208 volts a.c., three-phase, four-wire. The main bus shall be rated as noted on the drawings. Each switchboard shall have both a neutral and ground bar

.3 Construction

.1 Switchboards shall consist of the required number of vertical sections bolted together to form a rigid assembly. All edges of front covers or hinged front panels shall be formed. Provide adequate ventilation within the enclosure

.2 All sections of the switchboard shall be front and rear aligned. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible.

.3 The assembly shall be provided with adequate lifting means.

.4 Bus

.1 All bus bars shall be silver-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).

.2 A copper ground bus (minimum 1/4 x 2 inch), shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchboard.

.3 All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with conical spring-type washers.

.5 Wiring/Terminations

.1 Mechanical-type terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on the drawings.

.2 Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.

.3 Each switchboard shall have a neutral bar with incoming terminations equal to the phase terminations and load side terminations equal to the terminations of the switchboard load switches.

.6 Quick-Make/Quick-Break Fusible Switches

.1 Protective devices shall be quick-make/quick-break fusible switches. Fusible switches 30 amperes through 600 amperes frames shall be furnished with rejection class "R" or "J" type fuse clips unless otherwise scheduled. Fusible switches 800 amperes through 1600 amperes shall be furnished with class L fuse clips. Switches shall incorporate safety cover interlocks to prevent opening the cover with the switch in the ON position or prevent placing the switch in the ON position with the cover open. Provide defeater for authorized personnel. Handles shall have provisions for padlocking and shall clearly indicate the ON or OFF position. Front cover doors shall be padlockable in the closed position.

.7 Circuit Breakers

.1 Circuit breakers shall be molded plastic case type, quick-make, quick-break, with trip free common operating handle, position indication and common trip from thermal-magnetic trip device. Trip ratings shall be as indicated on the Drawings and minimum interrupting capacity shall be 65,000 RMS symmetrical amperes at 240 volts.

.8 Enclosures

.1 NEMA 1 Enclosure

.9 Nameplates

.1 Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating. Furnish master nameplate giving switchboard designation, voltage ampere rating, short-circuit rating, manufacturer's name, general order number, and item number.

.10 Finish

.1 All exterior and interior steel surfaces of the switchboard shall be properly cleaned and provided with a rust-inhibiting phosphatized coating.

.11 Metering

.1 Each switchboard shall have a microprocessor based meter installed complete with current transformers. The meter shall read and display all line-to-line and line-to-neutral voltages, current in each phase, power factor, power in kW, apparent power in kVA, kW demand, current peak demand, kW peak demand, kVA peak demand. The demand time shall be adjustable and the peak demand readings shall be resettable with a password. The unit shall be able to communicate via Ethernet. Provide three licensed copies of any software required to read the meter.

.2 A terminal strip shall be provided for the termination of the data cable.

.3 The meter shall be powered from the 208 volts in the switchboard.

.4 Provide a disconnect means to disconnect the phase leads to the meter from the power source.

.5 Provide fuses in a fuse holder for the power into the meter.

2.3 Fuses

.1 Fuses shall be Bussman, Low Peak sized according to the drawings.

.2 Provide three spare fuses of each size and type.

3. EXECUTION

3.1 Installation

.1 Panelboards shall be surface mounted in electrical rooms or flush mounted where indicated on plan drawings.

.2 Mount panelboards directly to concrete walls.

.3 Mount panelboards to finished walls using unistrut channels, minimum two channels per box.

.4 Install panelboards plumb and level.

.5 Install all switchboards on 4” concrete housekeeping pads.

3.2 Grounding

.1 Bond all panelboards per N.E.C.

3.3 Identification

.1 Provide name plates.

.2 Paint panelboards.

3.4 Fault And Coordination Study

.1 The manufacturer of the switchboards shall provide a fault and coordination study of the distribution system down to the load side of all distribution panels. The manufacturer shall use this study to select fuses and circuit breakers so that they coordinate. This study shall be provided with the shop drawing submittals. The engineer reserves the right to request changes in the devices at shop drawing time.

END OF SECTION

PART 1 - GENERAL

1.1 Product Data

.1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11– Electrical General Requirements.

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°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 to range from 3 to 8 times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

.5 Provide solid-state tripping system for all breakers larger than 225 amps with long, short, instantaneous function and ground fault protection.

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 Optional Features

.1 Include where indicated on drawings:

- .1 Shunt trip.
- .2 Auxiliary switch.
- .3 On-off locking device
- .4 Handle mechanism.
- .5 Non-auto.

2.4 Enclosure for Individually Mounted Breakers

.1 Enclosure shall be CSA code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in “off” position, EEMAC-1 unless shown otherwise. Use EEMAC-4 for industrial application, enclosure for wet environment or as shown “WP” on drawings. Increase enclosure size above standard for large cables.

.2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

PART 3 - EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

.2 Identification: Provide lamicoid plate on each breaker showing voltage, source of supply and load being fed. Example - 120/208 V, 3 phase, 4W fed from LDP No.1 to Splitter Trough No. 1.

END OF SECTION

1. General

1.1 Description

.1 A 12 pole lighting contactor is required for cell lighting control.

.2 Supply and install contactors as indicated on drawings and specified herein to ensure a complete operational system.

.3 This specification covers contactors for voltages up to 600 V. Refer to drawings for voltage, amperage, number of poles, and auxiliary contacts.

1.2 Product Data

.1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Acceptable manufacturers: Allen Bradley, Cutler Hammer and Siemens, or approved equal.

1.3 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Contactors

.1 Contactors: to EEMAC No.1CS.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. This rating shall be on the basis of incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. All contactors shall have 120V operating coils.

.3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.4 Mount in CSA Enclosure 1 unless otherwise indicated.

.5 Include the following options in cover:

.1 Red indicating lamp.

.2 Hand-Off-Auto selector switch.

.6 Control transformer

.7 Lighting contactors to have minimum 30 amp contact rating.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Provide a size 4 nameplate indicating name of load controlled.

3. Execution

3.1 Installation

.1 Install contactors and connect auxiliary control devices where indicated on drawings and specified herein.

.2 Contactors shall be mounted separately in suitable CEMA-1 enclosures.

END OF SECTION

1. General

1.1 References

.1 IEC 947-4-1, Part 4: Contactors and motor-starters.

1.2 Related Work

.1 Connections to Mechanical Equipment Section 26 24 19 23

1.3 Starter Requirements

.1 In general, there are categories of starting equipment for three phase motors.

   .1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.

   .2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.

.2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Indicate:

   .1 Mounting method and dimensions.

   .2 Starter size and type.

   .3 Layout of identified internal and front panel components.

   .4 Enclosure types.

   .5 Wiring diagram for each type of starter.

   .6 Interconnection diagrams.

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 26 05 00 11 - Electrical General requirements.

.2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 Maintenance Materials, Special Tools and Spare Parts.

.2 Provide listed spare parts for each different size and type of starter:

.1 3 contacts, stationary.

.2 3 contacts, movable.

.3 1 contacts, auxiliary.

.4 1 control transformer[s].

.5 1 operating coil.

.6 2 fuses.

.7 10% indicating lamp bulbs used.

.8 1 spare starter c/w wrapper for each size used.

1.7 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Materials

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

.2 Starter to be supplied by Westinghouse, Cutler Hammer, Square D or Allen Bradley.

2.2 Enclosure

.1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight EEMAC 4.

.2 For all motors 22.4 KW and above, the starters shall contain thermistor control relay and accessories.

2.3 Manual Motor Starters

.1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break.

.2 Overload heaters, manual reset, trip indicating handle.

.3 Rated volts and poles to suit application.

.2 Accessories:

.1 Toggle switch: heavy duty labeled as indicated.

.2 Indicating lights: heavy duty type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include circuit breaker with operating lever on outside of enclosure to control circuit breaker, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 HOA Selector switches: heavy duty labeled as indicated. Reset button, convertible to off/auto or stop/start.

.2 Indicating lights: heavy duty type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.

.3 In addition to standard, 2-N/O and 2-N/C spare auxiliary contacts unless otherwise indicated.

.4 Control transformer 120 V of sufficient VA to handle coil and associated controls.

.5 120 V holding coil.

2.5 Control Transformer

.1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.6 Finishes

.1 Apply finishes to enclosure in accordance with Section 26 05 00 11 - Electrical General Requirements.

2.7 Equipment Identification

.1 Provide equipment identification in accordance with Section 26 05 00 11 - Electrical General Requirements.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, engraved as indicated.

3. Execution

3.1 Installation

.1 Install starters, connect power and control as indicated.

.2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits

.2 Verify that overload relay installed is correctly sized for motor used

.3 Record overload relay size and motor nameplate amperage

.4 Visual inspection of fuses and contactors

.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relays in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 26 08 00 11 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Mechanical Division 21, 22 and 23

.2 Motor Starters Section 26 24 19 22

1.2 Requirements

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.

.3 All control wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide three phase starters with fused 120 volt control transformers and overload relays.

.9 Provide all power wiring for all motors and control wiring as indicated on the drawings.

.10 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning equipment will be under a separate contract. Provide terminations in starters and MCC's for control wiring so that starter control circuits may be extended. Where 120 volt power is required for mechanical equipment, i.e. roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the work of this Division.

.11 Refer to Motor Control Equipment Schedule.

.12 Some specific definitions of equipment wiring responsibilities are as follows:

.1 Fans

.1 Provide all 120V and 208V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 21, 22 and 23. Fire alarm and smoke detection systems shall be wired to shut down fans by this Division.

.2 Pumps for Sprinkler System, Domestic Water, Plumbing & Drainage Systems

.1 Provide all 120V power wiring. Except where specifically noted otherwise, all control for fans is to be supplied, installed and wired from the starter control circuits to the equipment under Division 21, 22 and 23. Fire alarm and smoke detection systems shall be wired to shut down fans by this Division.

.3 Pumps for Sprinkler System, Domestic Water, Plumbing & Drainage Systems

.1 Provide all 120V wiring as shown on the drawings.

.4 Unit Heaters

.1 Provide power wiring and starters for unit heater fans. Install and wire line voltage thermostats supplied by others. Where thermostats are low voltage or pneumatic, control wiring is under Division 21, 22 and 23.

.5 Forced Flow Convectors

.1 Provide 120V power supply to the convectors. Starters, speed controllers and temperature controllers will be supplied and wired under Division 21, 22 and 23.

2. products

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors, and EEMAC 1 indoors switches to be H.P. rated, Westinghouse heavy duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

3. execution

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

1 GENERAL

THE PRODUCT SPECIFIED IS AC DANDY MODEL# 1B-DPP

1.01 SUMMARY

1.02 RELATED REQUIREMENTS

.1	Common Work Results for Electrical	Section 26 05 00
.2	Conduit	Section 26 05 33.11
.3	Low-Voltage Electrical Power Conductors and Cables	Section 26 05 19
.4	Outlet Boxes	Section 26 05 32
.5	Receptacles	Section 26 27 26.10

2 PRODUCTS

2.01 POSTS

.1 Car heater posts to consist of four sided hollow steel posts, rectangular base plate, split feed parallel blade, U-grounding slot receptacles complete with weatherproof covers.

.2 Car heater posts to be formed of 11 gauge steel with closed top, continuously welded joins, all buffed smooth. Base plates to be drilled to standard template for four (4) 12 mm anchor bolts. Each car heater post to be provided with handhole 75 mm x 150 mm with 11 gauge steel cover with neoprene gasket and brass holding studs. Below receptacle on each car post, provide four (4) 8/32 brass machine screws to allow for mounting of stall number or nameplate. Car heater posts to be finished in baked-on enamel, weatherproof type, over corrosion-resistant primer. Inside handhole, provide grounding stud. Posts to be single and/or double faced with one and/or double split feed duplex receptacles as indicated on drawings.

.3 Duplex receptacles to be parallel blade, U-grounding slot type previously specified, and CSA approved. Each duplex receptacle to be fitted with cast corrosion-resistant gasketed cover held to post by four (4) brass 8/32 machine screws to tapped holes in post. Covers to be fitted with two (2) cast gasketed spring loaded flip lids, one over each half of the duplex receptacle. Flip lids to be plastic type. Pot metal flip lids will not be accepted.

.4 All car heater posts to be provided with ground lugs to accommodate #10 ground conductor.

.5 Any posts out-of-line or out-of-plumb to be shimmed and/or reinstalled in a satisfactory manner.

.6 Full detailed shop drawings to be submitted to the Consultant for approval prior to fabrication.

2.02 CONCRETE BASES

.1 300 mm square x 1200 mm deep, 20 MPa installed by contractor as detailed on the drawings.

2.03 ANCHOR BOLTS

.1 Anchor bolts to be 12 mm galvanized, 300 mm vertical length with 50 mm right angle bend at bottom.

2.04 UNDERGROUND CONDUIT

.1 Schedule 40 PVC.

3 EXECUTION

3.01 INSTALLATION

.1 Install car heater posts where indicated on the drawings and 900 mm minimum from wheel stop.

.2 Install underground wiring in specified conduit with watertight connections. Schedule 40 PVC conduit.

.3 Install green insulated ground conductor in all runs.

.4 Schedule 40 PVC conduit to be installed 600 mm below finished grade in divider strips, 900 mm all other locations, 75 mm concrete envelope in parking lots and driveways. Concrete by electrical contractor.

END OF SECTION

1. general

1.1 Section Includes

.1 This section describes the materials and installation requirements for integrated transient voltage surge suppression devices (TVSS), also referred to as a surge protective device (SPD). These devices are used to protect AC electrical circuits from the effect of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and or capacitive load switching

1.2 References

.1 cUL 1449 Second Edition 2005 - Transient Voltage Surge Suppressors

.2 1283 - Electromagnetic Interference Filters

.3 ANSI/IEEE C62.41.1-2002 - IEEE Guide on the Surge Environment in Low Voltage (1000 V and Less) AC Power Circuits; C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits; and C62.45-2002 - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.

2. product

2.1 Transient Voltage Surge Suppression Device

.1 Integral Transient Voltage Surge Suppressors

.2 TVSS shall be Listed in accordance with cUL 1449 Second Edition 2005 and cUL 1283, Electromagnetic Interference Filters.

.3 Integrated surge protective devices (SPD) shall be Component Recognized in accordance with cUL 1449 Second Edition, Revision 2/9/2005 Section 37.3 and 37.4 at the standard's highest short circuit current rating (SCCR) of 200 kA, including intermediate level of fault current testing that will be effective 2/9/2007.

.4 TVSS shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50µs, 10kA-8/20µs).

.5 TVSS shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems.

.6 Recommended TVSS ratings:

1. Minimum surge current rating shall be 160 kA per phase (80 kA per mode) for service entrance and 80 kA per phase (40 kA per mode) for distribution applications.

2. cUL 1449 clamping voltage must not exceed the following:

VOLTAGE	L-N	L-G	N-G

120/208	600V	800V	800V

3. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.

.7 TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.

.8 TVSS shall be constructed of one self-contained suppression module per phase.

.9 Visible indication of proper TVSS connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each TVSS module shall be monitored on the front cover of the enclosure as well as on the module. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

.10 TVSS shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

.11 A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete TVSS or module.

.12 Terminals shall be provided for necessary power and ground connections.

.13 TVSS shall have a warranty for a period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

3. execution

3.1 Installation

.1 Install units integral to designated panelboards shown on drawings.

.2 Where units are mounted integral with panelboards, status LEDs shall be visible without removing covers.

END OF SECTION

1 General

1.1 Related Work

1.1.1 General Electrical Requirements Section 26 05 00 11

1.1.2 Exit Lights Section 26 53 00

1.2 Documents

1.2.1 This section of the specifications forms part of the Contract Document and is to be read, interpreted, and co-ordinated with all other parts.

1.3 Work Includes

1.3.1 Supply and installation of luminaires complete with lamps, ballasts, supports and accessories, and for the supply and installation of plaster frames, trim rings and back boxes for plaster or dry wall ceilings or concrete. The luminaire schedule is shown on the drawings.

1.4 General Requirements

1.4.1 All lighting fixtures will be purchased by the Contractor unless noted otherwise. Include in the tender price administration of all shop drawings, purchase of all lamps, receiving fixtures on site, uncrating of all the lighting fixtures and clean up.

1.4.2 Install lighting as shown on Architectural and Electrical Drawings and as indicated in Contract Documents.

1.4.3 Provide and install all materials, components, and services necessary for a complete power and communication wiring distribution system for lighting.

1.4.4 Prepare all forms to show compliance with applicable energy use regulations.

1.4.5 Submittal of a bid for this project shall include a written acknowledgement of these terms from the Contractor.

1.4.6 Substitutions for the specified lighting products are not acceptable and will not be considered. Failure to include one of these specified products as part of the Base Bid may, at the discretion of the Owner, invalidate the entire lighting product bid and exclude the contractor from further consideration.

1.4.7 Within seven (7) working days of contract award, successful Contractor shall submit a complete list of lighting products he intends on furnishing with manufacturer and catalogue designations, along with currently quoted lead times for delivery of same. Should the Contractor anticipate that the delivery schedule of any specified product may adversely impact the construction schedule, he shall bring it to the attention of the Owner at this time.

1.5 Related Sections

1.5.1 Section 26 05 00 11: General Electrical Provisions

1.5.2 Section 26 05 33: Conduits, Conduit Fastenings, and Conduit Fittings

1.5.3 Section 26 05 19: Wires and Cables

1.5.4 Section 26 05 32: Outlet Boxes, Conduit Boxes, and Fittings

1.5.5 Section 26 05 19 11: Wiring Devices

1.5.6 Section 29 05 29: Fastenings and Supports

1.5.7 Section 26 05 26 10: Grounding

1.6 References

1.6.1 National Fire Protection Association (NFPA) Standard, current edition.

1.6.2 Underwriters' Laboratories Canada (ULC).

1.6.3 Illuminating Engineering Society of North America (IES).

1.6.4 Canadian Standards Association (CSA).

1.6.5 CGSB 31-GP-103Ma, heavy Phosphate conversion coatings for Iron and Steel (for Corrosion Resistance).

1.6.6 CGSB 31-GP-105Ma, Zinc Phosphate Conversion Coatings for Paint Base.

1.6.7 CGSB 31-GP-106M, coating, Conversion, Iron Phosphate, for Paint Base.

1.6.8 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by provincial, municipal or other regulatory agencies having jurisdiction.

1.6.9 Luminaires to conform to CSA C22.2 No. 9, ballasts to CSA C22.2 No. 74, ANSI C82.1 and lamps.

1.7 Submittals, Shop Drawings, and Product Data

1.7.1 Submittals

1.7.1.1 Submit shop drawings, samples and product data in accordance with Section 26 05 00 11 General.

1.7.1.2 Provide the required number of submittals promptly and deliver through appropriate channels, leaving sufficient time for adequate review and possible resubmittals without jeopardizing Project Schedule.

1.7.1.3 Contractor is responsible for all verification and actual field dimensions, quantities, co-ordination, and compliance with Contractor Documents.

1.7.1.4 Submit driver shop drawings with each applicable fixture shop drawing.

1.7.2 Contractor shall provide fully dimensioned shop drawings for all fixture types and all custom mounting hardware.

1.7.2.1 No release of orders for lighting equipment shall be made until review of submittals is complete.

1.7.2.2 Submit shop drawings for all products as follows:

1.7.2.2.1 Provide complete, fully dimensioned detail drawings including all major components and details of fabrication.

1.7.2.2.2 Provide requisite schematics and plans indicating assembly and installation of components.

1.7.2.2.3 Provide inventory of all equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.

1.7.2.3 Submit a list of fixture types and quantities and catalogue cuts for all product data. Such data shall show both technical and pictorial detail, marked specifically to show the optional or alternate components required, the exact catalogue number, and type designation corresponding to the type indicated in the Fixture Schedule. Include this data also with Maintenance Manual with the Consultant's review stamp.

1.7.2.4 Manufacturer's product data shall be marked clearly to indicate all technical information that indicates conformance to all specified requirements in Contract Documents. Include the following information for all fixtures not listed as pre-approved in the light fixture schedule:

1.7.2.4.1 Manufacturer's catalogue sheets of standard fixtures, indicating materials, gauges, dimensions, standard finishes available, weights, CSA approval

1.7.2.4.2 Photometrics from an independent testing laboratory calculated according to IES standards. Photometrics shall include the following:

- For lighting fixtures used for general illumination:
  - ∞ Candlepower distribution curve and table. Data in table shall have vertical angles no greater than 10º increments, (5º, 15º, 25º, etc.,). All asymmetric distributions shall have quadrants represented in 22.5º increments, (parallel, 22.5º, 45º… normal), or sufficient increments to fully describe asymmetric light distribution.
  - ∞ Coefficient of Utilization (CU) tables.
  - ∞ Visual Comfort Probability (VCP) table (fluorescent fixtures only) for 100 foot candle room with reflectance of 80% ceiling, 50% wall, and 20% floor with task height of 2.5'.

  - ∞ Zonal lumens stated numerically in 10º increments, (5º, 15º, etc.,) or smaller increments for narrow beam fixtures.
- For all other fixtures, provide candlepower distribution curve and table with minimum 10º increments (5º, 15º, etc.,) or smaller degree increments for narrower distribution fixtures.
- For all downlights, provide Footlambert measurements off of reflector surfaces, which shall be equal to or less than fixtures listed as pre-approved.
- For floodlights: vertical and horizontal beam spread, beam lumens, beam efficiency and complete photometric data. Computer printout for aiming angles.
- For area lighting: a computer-generated printout of lighting analysis with listing of average illumination in lux, the maximum/minimum ratio and the average/minimum ratio within the area to be illuminated.
- Submittals shall indicate complete driver information on all LED fixtures.
- The equipment manufacturer shall provide additional information or demonstrations as required by the specifier to demonstrate conformance with Part 2 of this Section. Additional information or demonstrations shall only be required prior to submittal of final approval and as notified in writing by the supplier or should product to be delivered to the Site differ from materials described in final submittals or published product literature. All demonstrations are to be at a location, time and in a manner co-ordinated with and approved by the Consultant.

1.8 Delivery & Storage

1.8.1 Equipment shall be individually wrapped and sealed and substantially crated for shipment. All handling and shipping shall be performed in accordance with Manufacturer's recommendations. Store products in unopened cartons in a protected location.

1.9 Warranty

1.9.1 Provide Contractor warranties as well as factory warranties. All equipment and labour in this Contract shall be free from defects in products or workmanship for 12 months after date of acceptance by the Owner, unless otherwise noted or approved by Owner.

1.10 waste management and disposal

1.10.1 Refer to section 26 05 00 11 – Electrical General Requirements.

2 Products

2.1 General

2.1.1 Provide all products with CSA labels or appropriate approvals for all mounting conditions.

2.1.2 Provide lighting fixtures new and complete with mounting accessories, junction boxes, trims, and lamps.

2.1.3 All products of the same specified type are to be of the same manufacturer.

2.1.4 Fixture type catalogue number does not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for all mounting conditions.

2.1.5 All fixtures shall have the appropriate frame that is compatible with the ceiling type into which they are installed. Verify all ceiling types at the shop drawing review. Coordinate with the architectural reflected ceiling drawings.

2.1.6 Provide appropriate accessories for proper mounting of all fixtures. For example, include plaster frames for plaster ceiling. For fixtures in rated ceiling, provide firestop protection as specified elsewhere. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.

2.1.7 Recessed luminaires shall be of the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access.

2.1.8 Provide only luminaires, which are structurally, well designed and constructed and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers catalogues and data sheets. Luminaires shall be designed for adequate dissipation of heat as specified in Section 26 05 00 11 - Electrical General Requirements.

2.1.9 Luminaire bodies for corrosive areas to be non-metallic or epoxy-coated.

2.1.10 Hinges, latches and other exposed hardware to be non-metallic or 316 stainless steel for corrosion-resistant luminaires. Use 316 stainless steel chains for suspension of corrosion resistant and vapour tight luminaires.

2.1.11 Where light fixture or light fixture suspension apparatus penetrates metal pan or sheet metal ceiling or canopies, an approved copy of the shop drawings of those fixtures shall be provided to the ceiling manufacturer. Apertures in the ceiling or openings for suspension cables shall be pre-cut by the ceiling manufacturer to suit light fixtures. Instruct the manufacturer accordingly.

2.1.12 General

2.1.12.1 Fixtures in non-accessible ceilings and in columns shall be accessible by utilizing junction boxes, ballasts, and transformers through fixture apertures.
2.1.12.2 No metal clips, screws, angles, etc. shall be visible when the fixture is viewed from below.
2.1.12.3 All mounting frames installed in damp locations or in plaster ceiling shall be galvanized.
2.1.12.4 Extruded fixture housings shall have a minimum thickness of 2.3 (3/32") mm and be smooth and free of tooling lines. Die cast end plates and joiner sections shall have a minimum thickness of 2 (3/32") mm thickness and concealed fasteners.
2.1.12.5 Die casts shall be smooth, free of pits, grooves, and imperfections.
2.1.12.6 Spinning shall be smooth and clean with finished edges, and free of spinning lines.
2.1.12.7 Sheet metal fixture housings shall be of welded construction with seams filled and ground smooth. Any exceptions shall be noted under individual fixture types.
2.1.12.8 All adjustable fixtures shall have locking rotation and tilt devices.
2.1.12.9 Pendant-mounted fixtures shall have stems with ball swivels or be cable-mounted to allow 45 degrees swing in any direction from vertical.
2.1.12.10 Ball swivels and cable end hardware shall be concealed with sleeves.

2.2 <u>Wire Guards</u>

2.2.1 Provide wire guards to all fixtures that are less than 2400 mm (8'-0") above adjacent floor, unless noted otherwise in the fixture schedules.

2.2.2 All fixtures in storage rooms, service rooms and mechanical areas shall have wire guards.

2.3 <u>STANDARD LEDS LUMINAIRES</u>

2.3.1 Consider LED sources based on durability, energy efficiency, and reduced maintenance.

2.3.2 LED luminaires are to be provided by manufacturers with a minimum (10) years' experience and provide minimum (5) years warranty on all electrical parts.

2.3.3 LED components and LED luminaires shall comply with ANSI chromaticity standards, IES-TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources Standard, LM79 and IES LM80 lumen maintenance testing standards.

2.3.4 Dimmable LEDs will utilize Constant Current Reduction or Pulse Width Modulation controls.

2.3.5 White LED luminaires must be provided in 4100K, or otherwise indicated in the drawings.

2.3.6 Color changing LED luminaires shall provide full spectrum color changing capability through the use of red, blue, green and white (amber) LED's.

2.3.7 LED lighting systems with unmatched drivers and power supplies will not be considered.

2.3.8 They must respond cUL recognized and CSA compliant.

2.3.9 They should comply with CSA-C866-12 Performance for LED luminaires.

2.3.10 Intensity:

2.3.10.1 LEDs to be designed to operate at 20 milliamps (mA).

2.3.10.2 Fixture LED design will provide long-life operation in accordance with the technical spec designed for each fixture and they will considerer heat dissipation and other degradation factors in order to offer the guarantees established.

2.3.11 Operating Life

2.3.11.1 They must be designed to operate upwards of 50.000 hours at 25°C ambient temperature. LEDs fixtures must resist shock, vibration and can be cycled on and off without degradation.

2.3.12 Voltage/Design Current

2.3.12.1 Drive current and light output are directly related, exceeding the maximum current rating will produce excessive heat within the LED chip due to excessive power dissipation and result in reduced light output and operating life.

2.3.12.2 LEDs fixtures that are designed to operate at a specific voltage contain a built-in current-limiting resistor. Additional circuitry may include a protection diode for AC operation or full-bridge rectifier for bipolar operation. The operating current for a particular voltage is designed to maintain LED reliability over its operating life.

2.3.13 LED Power Supplies

2.3.13.1 LED fixture power supplies must be compact and electronically stabilized. The wide range of input voltage must be available from 120 to 347 VAC use on single-phase AC power lines. These supplies are available in 10Vdc and 24Vdc outputs. They must be protected against open circuit, short circuit, overload and overheating.

2.3.14 They must respond cUL recognized and CSA compliant.

2.3.15 They must comply with CAN/CSA-C22.2 NO. 250.13-12 – LED equipment for lighting applications.

3 Execution

3.1 Verification of Conditions

3.1.1 Confirm all ceiling depths against the final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Consultant immediately of any discrepancies prior to ordering of the fixtures or proceeding with the work. Prior to order of modified fixtures for non-standard ceiling depths, confirm with the Consultant(s).

3.2 Installation - General

3.2.1 Lighting fixtures shall be installed as indicated on architectural reflected ceiling plans, Electrical Drawings and per approved shop drawings.

3.2.2 Lighting fixtures are indicated in the Luminaire Schedule by means of type numbers that correspond to similar numbers on the plans.

3.2.3 Lighting fixtures shall be installed in accordance with fixture manufacturer's written instructions, applicable requirements of CED, applicable authorities, and with recognized industry practices.

3.2.4 Verify locations and spacing of lighting fixtures with reflected ceiling plans and notify Consultant of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

3.2.5 Work shall be co-ordinated with other trades. Lighting fixture locations shall have priority over location of ducts, diffusers, sprinklers, smoke detectors and other non-structural obstructions. Identify conflicts to designer for assistance in resolving.

3.2.6 All fixtures shall be supported directly from the building structural members or from bridging attached to the structural members by rod hangers and inserts. Provide all necessary hardware and blocking to ensure that fixtures hang true.

Install recessed luminaires to permit removal from below, unless noted otherwise, to gain access to outlet or pre-wired luminaire box. Make final connection from boxes to luminaires with flexible conduit. AC-90 (with No. 12 AWG conductors) may be used but shall be independently supported, (e.g. not from connectors), and have anti-shorts installed. With either type of connection method, the length of the flexible connection shall not exceed 2 meters.

3.2.7 For recessed luminaires , support luminaires independent of suspended ceiling system to comply with seismic requirements.

3.2.8 Where luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaires with sheet metal screws into a T-bar at both ends.

3.2.9 When luminaires are installed in valances with solid lens, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.

3.2.10 Fixtures installed in suspended T-bar ceiling shall be equipped with T-bar clips. Clips shall be securely fastened to suspended T-bar ceiling system framing members. The light fixture shall be centered in the ceiling grid opening. Provide a minimum of two clips, on each on diagonal opposite corners, and provide more clips if required by local authority having jurisdiction. Clips shall be reusable and not closed down with rivets. Four wire hangers are to be installed for each fixture, one at each corner of each fluorescent fixture location.

3.2.11 Provide every light outlet in the building with a lighting fixture as instructed, complete with accessories necessary for its proper installation and operation. If a fixture type is not designed for any particular outlet, obtain the necessary details from the Consultants prior to submission of tender. Alternatively, supply a suitable fixture for the outlet involved as directed by the Consultants.

3.2.12 Effectively ground all fixtures.

3.2.13 For exact location of ceiling mounted lighting fixtures refer to Architectural reflected ceiling plan.

3.2.14 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Consultant prior to rough-in.

3.2.15 All fixtures shall be installed with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in the manufacturer’s installation instructions.

3.2.16 Ceiling insulation shall be a minimum of 75 mm (3”) away from fixture.

3.3 <u>Workmanship</u>

3.3.1 Provide suitable extension couplings for wall mounted luminaires.

3.3.2 Hang and mount luminaires to prevent distorting frame, housing, sides or lens frame and permit correct alignment of several luminaires in a row.

3.3.3 Support luminaires as indicated on the drawings, level and plumb, and turn with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housings rigidly, and adjust to neat flush fit with mounting surface.

3.3.4 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

3.3.5 Where luminaires are required to be supported from the building structure, use a minimum of 2 - 6.35 mm rods per luminaire.

3.3.6 Apply a protective coat of bituminous paint to surfaces of recessed luminaires, which are in contact with concrete.

3.4 Installation of Recessed Fixtures

3.4.1 Holes shall be cut to exact fixture size so that no gaps will be present when trims or cones are installed.

3.4.2 Round holes in acoustical tile ceilings shall be cut using adjustable diameter cutter on slow speed drill press.

3.4.3 Holes in metal pan and/or sheet metal ceiling and/or ceiling canopy shall be pre-cut by ceiling manufacturer based on approved shop drawings of the light fixtures located in these areas. Electrical contractor shall be responsible for co-ordination between Division 26 and metal ceiling manufacturer(s) for the installation of light fixtures in areas with metal ceilings.

3.4.4 Provide plaster frames or plaster trim as required and turn same over to the ceiling section for installation.

3.4.5 Installation of trims shall be tight with no gaps or light leaks. Reflector cones, baffles, aperture plates and decorative elements shall be installed after completion of plastering, ceiling tile work painting, and general clean up in areas. Caulking or sealing fixture trim cones to ceiling to eliminate light leaks or gaps shall not be acceptable.

3.4.6 Where fixtures are recessed into non-accessible ceiling space and the fixtures specified are not pre-wired, wire to an outlet box adjacent to each fixture and visible only when the fixture is removed. Connect to the fixture with suitable high-temperature wire in at least 1200 mm (48") of flexible conduit. Install fixtures so that they may be readily removed to gain access to these outlet boxes.

3.4.7 Provide site-fabricated insulation shields over all recessed lighting fixtures without insulation rated housing which are installed in ceilings above areas where thermal insulation is to be installed. Shields shall be constructed of a size and material acceptable to the Electrical Inspector.

3.5 Installation of Linear Fixtures

3.5.1 Linear fixtures, surface mounted or suspended, shall not have more than 6 mm (1/4") variation in alignment for any 5 metre (17 feet) run.

3.5.2 In spaces with metal pan or sheet metal ceiling, installation of linear fixtures shall be co-ordinated with ceiling supplier and installer. Refer to mounting details on Electrical, Architectural, Interior Design drawings and manufacturer recommendations.

3.6 Field Quality Control

3.6.1 Operate each fixture after installation and connection. Each fixture shall be inspected for proper connection and operation.

3.6.2 Perform testing of operation of temporary or emergency power systems.

3.6.3 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

3.7 Luminaire Wiring

3.7.1 Connect recessed luminaires to outlet boxes with maximum 10-mm (0.4”) flexible conduit and 90º C wire.

3.8 Branch Circuit Wiring

3.8.1 Where the drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated as required. Run conduit parallel to major building lines.

3.8.2 Conductors shall be #12 R90 XLPE minimum.

3.8.3 Provide a neutral for each circuit (phase conductor).

3.8.4 Conduits shall be sized in accordance with code requirements for wire count installed. In no case shall conduit less than 19 mm be used for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 70% as per Canadian Electrical Code.

3.9 Fixtures in Service Rooms

3.9.1 Before mounting any fixture in mechanical, electrical or other service room obtain written approval of layout to be used. Layout must suit equipment limitations in the room.

3.10 Adjustments

3.10.1 All adjustable fixtures shall be aimed as instructed by the Consultant. Personnel, lifts, and ladders shall be provided by contractor as required.

3.10.2 Adjust exit sign directional arrows, if required.

3.11 Cleaning

3.11.1 Co-ordinate project close out with Section 01 00 10 General Requirements.

3.11.2 Remove all plastic bags from parabolic fixtures after construction is finished and prior to final acceptance.

3.11.3 All necessary equipment, materials, wiring, and fixtures shall be removed from those areas affected by the construction. Materials that are not part of the lighting or electrical distribution system shall be removed from the Site.

3.11.4 All lighting fixtures shall be cleaned in a manner approved by the manufacturer and shall be free of dirt and debris upon completion of installation.

3.12 Demonstration

3.12.1 Co-ordinate project close out with Section 01 00 10 General Requirements.

3.12.2 Building personnel shall be trained to operate lighting control system.

3.13 Protection

3.13.1 Lighting fixtures, once installed, shall be protected from damage during the remainder of the construction period.

END OF SECTION

1. General

1.1 Product Data

.1 Submit product data in accordance with Section 26 05 00 11 - Electrical General Requirements.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Standard Units

.1 Housing: Metal in admin areas, Vandal proof in cell areas

.2 Lamps: energy efficient LED.

.3 Operation: 25 years of continuous operation without relamping.

.4 Green Running Man

.5 Multi – KO mounting not accepted.

.6 Acceptable product or material: as indicated on drawings.

3. Execution

3.1 Installation

.1 Install exit lights.

.2 Connect fixtures to exit light circuits, voltage as specified on the drawings, single circuit operation.

.3 Ensure that exit light circuit breaker is locked in on position.

.4 Where exit lights are mounted on T-bar ceilings, support exit light independent of ceiling tile. Support from tile only will be rejected.

END OF SECTION

1. General

1.1 Summary of Work

.1 The work includes: Supply and installation of fibre optic and copper backbone cabling, supply and installation of Augmented Category 6 (Category 6A) Voice and Data Horizontal Distribution Cabling; Supply and installation of associated passive network equipment.

.2 The voice/data communication systems shall comprise all components specified, implied or otherwise necessary to constitute a fully operational system. The work includes, but is not necessarily limited to, the following:

.1 Provision of fibre optic and copper backbone cables interconnecting the Main Telephone Room and the Typical Communications rooms, etc.

.2 Provision of cable termination panels, patch panels, and patch cords to support the system. Provision of equipment racks.

.3 Provision of Voice/data outlets indicated in various locations. Required hardware includes, but is not limited to, cross-connection system, termination blocks, fastening devices, system patch cords and all required accessories to comply with this Specification.

.4 Provision of direct horizontal runs of unshielded twisted pair (UTP) Category 6A cables in star configuration from Communications Rooms/Closets to the outlets for all data and voice circuits identified on drawings.

.5 Termination of all fibre optic and UTP cables at panels, outlets and Communications closets. Termination and hardware are defined as all labour and materials required to terminate all cables.

.6 Provision of all cable supports and ties required to support the cabling system for this installation.

.7 Testing certification and warranty of all cabling and components which are within the scope of this Contract.

.8 Provision of as-built AutoCAD drawings fully documenting the cabling.

1.2 Work Not Included

.1 The work not included in this contract is the supply of communications hub and switching equipment. Testing and energization of hub equipment and LAN communications to be carried out by others.

1.3 Training

1.4 References

.1 All workmanship and materials supplied shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction.

.2 All cabling system components shall be Underwriters Laboratories (UL) Listed and shall be marked as such. In cases where UL has no published standards for a component, any equivalent national independent testing standard shall apply and the item shall be appropriately marked.

.3 The product specifications, design considerations, and installation guidelines provided in this document are in part derived from recommendations found in recognized telecommunications industry standards. The following are used as reference:

1. Spaces and Pathways
   TIA-569-B (2004) – *Commercial Building Standard for Telecommunications Pathways and Spaces*

2. Grounding
   ANSI-J-STD-607-A (2002) – *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications*

3. Cabling Systems
   TIA/EIA-568-B.1 (2002) – *Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements*
   TIA/EIA-568-B.2 (2001) – *Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components*
   ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling*ANSI/TIA/EIA-568-B.3-2000 - Optical Fiber Cabling Components Standard

   ANSI/TIA/EIA-568-B.3-1-2002 - Optical Fiber Cabling Components Standard Addendum 1 – Additional Transmission Performance Specifications for 50/125 µm Optical Fiber Cables

   TIA/EIA-862 (2002) – *Building Automation Systems Cabling Standard for Commercial Buildings*

4. Cabling Administration
   TIA/EIA-606-A (2002) – *Administration Standard for Commercial Telecommunications Infrastructure*

5. Networking
   IEEE Standard 802.3an (2006) – *10GBASE-T* (10 Gb/s Ethernet operations over balanced twisted-pair cabling)

6. Design
   BICSI *Telecommunications Distribution Methods Manual (TDMM)* – 11th edition

7. Installation
   BICSI *Information Transport Systems Installation Manual (ITSIM)* – 4th edition (2004)

1.5 System Description

.1 Structured system of communication cables, copper Augmented Category 6 UTP and 850 nm laser-optimized 50/125 µm optical fibre, installed within the building for distributing voice and data.

.2 Connect each communication outlet in physical star configuration to communications closet.

.3 Installed in physical star configuration with separate horizontal and backbone sub-systems.

.4 To avoid network problems caused by impedance balance, and attenuation differences, all passive equipment being installed in the horizontal network shall be of the same type and from the same manufacturer.

.5 The structured cabling system shall be composed of the following interdependent sub-systems:

.1 50 pair service cable required for new Demark

.2 103mm conduit from Lan room to emergency response vehicle

.3 103mm spare

.4 103mm conduit for CATV

.1 Colour coding of pairs: tracer coloured white paired with each of blue, orange, green, and brown.

.2 Colour coding of jacket is blue, Belden IBDN outlets as follows:

a. Voice outlets to be WHITE

b. Network outlets to be BLUE

c. Radio outlets to be RED

d. Municipal outlets to be BLACK

.3 Standalone computer to outlets be yellow in color, locations of standalone as follows:

a. Mechanical room

b. Elders room

c. Front counter

d. Overnight exhibit room

.4 Fire rating: plenum rated overall CMP (FT-6) compliant.

.5 Patch cable colours:

a. Voice to be WHITE in color

b. Standalone computer to be YELLOW

c. Data/network to be BLUE

d. Radio system to be RED

1.6 Qualifications

.1 The Telecommunications Contractors shall be an Approved RCMP System Vendor experienced and trained by the manufacturing company, in all aspects of the placement, terminating, connecting and testing of products described herein and provide certified proof prior to start of work. Contractor must be on current list of RCMP Certified Contractors.

.2 The Contractor shall be a Belden Certified System Vendor (CSV) experienced and trained by the manufacturing company, in all aspects of the placement, terminating, connecting and testing of products described herein and provide certificate of proof prior to start of work.

.3 The Contractor shall have a minimum of one (1) RCDD “Registered Communications Distribution Designer” recognized by BICSI “Building Industry Consulting Services International” on staff at local offices (the term “Local offices” as applied to RCDD, Registered Communications Distribution Designers, refers to anywhere in the Province of Alberta) and provide certificate of proof prior to start of work.

.4 Communications contractor shall supply and install a complete system for voice and data.

.5 The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size. The Contractor shall demonstrate proven expertise in the implementation of network cabling. Expertise can be illustrated through the inclusion of details of at least three projects involving the design and installation of a Category 5e, Category 6, or Augmented Category 6 (Cat 6A) balanced twisted-pair cabling system within the past two-year period. Names and contact information for each of the three projects shall be included. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and proposed Augmented Category 6A metallic premise distribution systems and have personnel who are adequately trained in the uses of such tools and equipment.

.6 The communications installer shall be a Communications Cabling Specialist certified by the Dept. Of Labour and obtain all required permits.

1.7 Shop Drawings

.1 Submit shop drawings and product data, for:

.1 Fibre optic cable

.2 UTP communication cable

.3 Communications Equipment Racks, Cable management

.4 Patch panels and patch cords

.5 Communication Outlets

.6 Bix mounts, connectors, adapters.

1.8 Warranty

.1 The warranty period with regard to the project is for 25 years from the date of Substantial Performance of the Work or those periods specified in the Contract Documents for certain portions of the Work of Products.

.2 The Contractor shall be responsible for the proper performance of the Work.

.3 The Contractor shall correct promptly, at the Contractor’s expense, defects or deficiencies in the Work which appear prior to and during the warranty periods specified in the Contract Documents.

.4 The Owner shall promptly give the Contractor notice in writing of observed defects and deficiencies that occur during the warranty period.

.5 The Contractor shall correct or pay for damages resulting from corrections made under the requirements of paragraph 1.8.3.

.6 The Contractor shall be responsible for obtaining Product warranties in excess of one year on behalf of the Owner from the manufacturer. These product warranties shall be issued by the manufacturer to the benefit of the Owner.

.7 The Contractor shall provide a twenty-five (25) year Extended Product Warranty and Lifetime Application Assurance Warranty for the Communications Network. This warranty shall be backed up by the manufacturer and taken over by the manufacturer or his representative if the Contractor fails to follow through with the requirements of the warranty.

.8 The Communications Network is defined as all required passive equipment and cabling, including hardware, terminations, and jacks, configured to provide data and voice connectivity from each data or voice outlet provided by the Contractor in this Contract.

.9 The System Assurance shall cover the applications that the installed system is designed to support for a twenty-five (25) year period.

.10 The copper system shall be constructed to conform to ANSI/TIA-568-B.2-10-2008 – Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling Commercial Building Telecommunications Cabling Standards.

.11 The fiber system shall be constructed to conform to ANSI/TIA/EIA-568-B.3-2000 - Optical Fiber Cabling Components Standard and ANSI/TIA/EIA-568-B.3-1-2002 - Optical Fiber Cabling Components Standard Addendum 1 – Additional Transmission Performance Specifications for 50/125 (m Optical Fiber Cables

.12 The Extended Product Warranty and the Systems Assurance together comprise the Structured Cabling System Quality Assurance Program.

.13 Upon successful completion of the Structured Cabling System installation and subsequent testing by certified technical personnel the Contractor shall provide to the Owner a numbered certificate registering the installation.

2. Products

2.1 General Description

.1 The Government of Canada Building will be served by a Fibre Optic Data and Augmented Category 6 Data Riser System. This tender includes provision of all fibre optic and copper systems for the building.

.2 All Horizontal Augmented Category 6 UTP Cable will be installed in conduit and cable tray as indicated. The principal cross-connection point for the riser system and for the voice network will be the LAN/Tel room.

.3 All horizontal voice and data distribution cables shall be terminated at the user end on a communications (single, dual or quad, as specified in drawings) outlet. The Data RJ-45 jack shall be appropriately numbered and identified with a Belden or equal computer label; the voice RJ-45 jack shall be appropriately numbered and identified with a Belden or equal telephone label.

.4 All products must be accompanied with 3rd party test results stating that each component is Augmented Category 6 compliant, and 3rd party test results that show the components when tested in a worst case channel configuration will exceed Category 6A channel requirements with additional margin (Clause 3.2.2,2) at both maximum length of 100 meters and minimum length of 12 meters as per ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100 Ω Augmented Category 6 Cabling*

2.2 <u>Main Communications Room</u>

.1 General Equipment Installation:

.1 LAN/NSS Racks

- Supply and install 2-post 19" steel distribution floor mount racks with vertical cable management on both sides of the rack in locations as identified on drawings for voice and data systems.
- Minimum of two racks required in LAN/TEL room, (1 rack for data and 1 rack for voice)
- Racks are anchored to floor with four bolts in concrete
- Rack specification is minimum 44U, maximum 47U or 84 inches in height, black color.
- Rack features:
  - Constructed with minimum 11ga. “U” steel welded together and to rack base 10-32 holes on the front and rear of the vertical rails with reference U-spacing markings for standard 19" TIA/EIA mounting
  - Post sides require a minimum of 3 holes for mounting VCM or ganging racks together
- Vertical Cable Management features:
  - 16 ga. steel with a minimum of 4 fabricated 13 ga. stiffeners inside for strength
  - Channel Cable Management, deep style (9" deep)
  - Minimum of 3 mounting holes to rack with fabricated 11 ga. reducers for strength
  - Hinged front doors with minimum 3 magnetic catches
  - Lance projections at rear for external cable ties
  - Minimum of 20 opening on each sides for wire distribution
  - Minimum of 8 larger opening on rear for wire distribution
- 1x flush mount shelf for each rack, cantilevered, 2 U high
- Equipped with horizontal cable management guide for each jack strip installed
- Equipped with 1x 6 to 8 outlet power bar, horizontally mounted at top of each rack, equipped with a 5 meter cord and 115 VAC 20 Amp plug.

.2 LAN/NSS cabinets

- NSS cabinet should have the following specification; Basis of design – CableTalk:
  - 30" x 42" x 83" (Width x Depth x Height) with cable trough roof
  - Tapped style mounting angles
  - Solid side panels
  - Perforated doors with flush mount locks
  - Key/ Dial combo lock
  - Channel Cable Management, deep style (9" deep)
  - Horizontal cable management 4U x 3" deep
  - 2x 6 - 8 outlet 20A powerbar
  - 2 fans
  - 1x 2-position mount shelf for vented platform with 17’ depth, 2U high

.3 Install racks and cabinets as detailed on drawing.

.2 Fibre Optic Cable Installation and Termination:

.1 Supply and install 1 (one) 24-port rack-mount Fibre Patch panel in each Data Rack as shown on drawings, for termination of fibre backbone cables being installed to interconnect each of the Communication Rooms to the MTR. All ST adapters, connectors, patch cords and terminations shall be provided. All fibre pairs to be labelled corresponding to Patch Panel ports, using consistent numbering schemes. Horizontal Cable Management to be installed in rack as indicated in drawings. Patch Panel shall be Belden Fiber Express or approved equal. (Not Required)

.3 Data Cable Installation and Termination

.1 Supply and install adequate number of 24 or 48-port patch panels in data racks to service all data distribution, plus 25% spare capacity (see drawing).

.2 Supply, install and terminate the horizontal (DATA) 4pr Augmented Category 6 UTP copper Cables from Data Distribution Patch Panels in Data Rack to each Data and Data/Voice Outlet defined by the drawings. Each data jack and patch cables at the device end shall be identified with the corresponding data patch panel port. Supply and install patch cords for all terminated data ports for both ends of each run.

.3 Supply and install horizontal and vertical cable management Guides as per drawing.

.4 Data patch panels shall meet Augmented Category 6 requirements/standards. Connectors shall be Belden 10GX MDVO Style Modules or approved equal.

.4 Voice/Riser Cabling Installation and Termination

.1 Supply and install 24/48 port patch panels for termination of incoming Telco cable.

.2 Supply and install adequate number of 24/48-port patch panels in voice racks to service all voice distribution, plus 25% spare capacity (see drawing).

.3 Supply, install and terminate the horizontal (VOICE), 4pr Augmented Category 6 UTP copper Cables from Voice Distribution Patch Panels in voice rack to each Voice and Data/Voice Outlet defined by the drawings. Each voice jack shall be identified with the corresponding number on the Voice Distribution Field. Supply and install patch cords for all terminated voice ports, both ends of each run.

.4 Supply and install horizontal and vertical cable management guides as per drawing.

.5 Voice patch panels shall meet Augmented Category 6 requirements/standards.

.6 Connectors shall be Belden 10GX MDVO Style Modules or approved equal.

2.3 Horizontal communications cable

.1 4 pair, Augmented Category 6 , #23 AWG insulated copper conductor, 100 ohm, Unshielded Twisted Pair (UTP) riser cable (CMR) in separate outer jacket for voice/data service distribution to communications cabinets and all outlets. All cable to have a minimum FT-6 fire rated jacket, white colour for voice & data.

.2 Provide Belden 10GX 4-pair Augmented Category 6 cable

.3 Augmented Category 6 cable shall be installed for all horizontal communications data and voice requirements. The balanced twisted-pair cabling system shall support 10 Gb/s networking and shall provide guaranteed performance up to 625 MHz for a 4-connector, 100 m (328 ft) channel.

.4 All Augmented Category 6 cables shall conform to ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100* Ω *Augmented Category 6 Cabling*, CAN/CSA T529-95 Commercial Building Telecommunications Cabling Standard, and Horizontal Cable Section.

2.4 Communications Outlets

.1 Voice/Data Outlets to be: Augmented Category 6, modular, 8 pin for voice and data; single, dual or four port c/w SS face plates and mounting frame. Spare ports to be blanked off.

.1 Flush mounted. Belden 10GX or approved equal.

.2 Provide labelling as specified.

2.5 Patch Cables

.1 Patch cables shall be provided for all terminated voice and data ports, for both ends of each line. The cordage shall use 23 AWG solid copper conductors in a bonded pair configuration for reliable long-term channel performance to 625 MHz. The transmission characteristics of the cordage will be guaranteed to 625 MHz. The patch cables shall support 10 Gb/s, FT-4, 23 AWG copper, Belden 10GX or approved equal.

.2 The quantity of patch cables for connection between switches and patch panel in LAN room is to be at least the same amount as the number of ports on the horizontal patch panels. Length of the patch cables should be 7ft or 2 m.

.3 The quantity of patch cables for connection at the workstation end is to be at least the same amount as the number of ports on the horizontal patch panels. Length of the patch cables should be 15ft or 4.5 m.

2.6 Standard of Acceptance

.1 Belden IBDN Certified Structured Cabling System is specified as Standard of Acceptance.

2.7 Power Bars

.1 All communication racks shall have a 6 outlet, surge suppression, power bar mounted at the top of the rack.

2.8 Communications Cabinets

.1 19” steel Distribution Racks and LAN/NSS cabinets are required. (See section 2.2. above)

3. Execution

3.1 Installation of Cables

.1 General

.1 Install communication cables in accordance with Manufacturer’s recommendations and guidelines.

.2 Place all communication cables in conduits or cable tray as required, except within closets use conduits as available.

.3 Cable Labels:

.1 Electrovert Type “Z” cable markers sized to fit cables snugly.

.2 Self laminating, heat-shrink, one-piece, custom printed cable labels.

Cable labels can be self laminating embossed type in lieu of heat shrink.

.4 EMT type conduit “wall-stub” c/w flush installed device box shall be located in walls/partitions. Stubs shall be turned out into accessible ceiling space.

.5 Single and multi-gang type raised 4” square “tile” rings are also acceptable for use in new dry-wall type construction. Secure directly to face of metal studs. Multi-gang “tile” rings are to be adequately secured within partitions, on “both” left and right hand sides of same.

.6 Where the “grouping” of various systems outlets or multi type outlets in dry-wall type construction is desirable, the use of “box mounting brackets” are to be installed between, and secured to, both metal studs. To install suitably sized 4” square and/or 4 11/16” boxes c/w raised tile rings as may be required.

.2 Installation of Unshielded Twisted Pair (UTP) Cable

.1 Connect each outlet directly to a communications closets by a continuous UTP cable. There shall be no connector in the cable run between the communication outlet and the cable termination in the closet. Transition points between the communications closet and the communications outlet are disallowed.

.2 Horizontal cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundles, which will degrade the performance of those cables

.3 The maximum horizontal cable distance for data and voice circuits to be 90 m (295 ft.). This is the cable length from the mechanical termination of the UTP cable in the communications closet to the communications outlet. In establishing maximum distance, an allowance to be made for 3 additional meters (9.8 ft.) from the communications outlet to computer and 2 meters for patch cords at the closet.

.4 The following applies to cables installed in return air plenums without the use of tray.

.1 Where air plenum is accessible, adjustable cable straps may be used. Routing shall follow building grid lines.

.2 Where air plenum in not accessible, conduit raceway shall be provided to span inaccessible ceiling space.

.3 Cables crossing power cables or fluorescent light fixtures (outside conduit) must do so at right angles.

.5 Install coaxial cables and outlets in accordance with manufacturer’s recommendations.

.6 When installing UTP cable, follow the separation distances from EMI sources detailed in the table:

Source of Electro-Magnetic Interference (EMI)	Minimum Separation Distance from a source Carrying:	
	< 2 kVA	2 – 5 kVA
Unshielded power lines, electrical equipment near open/non-metal pathways.	12.7 cm 5 in.	30.5 cm 12 in.
Unshielded power lines, electrical equipment near grounded metal pathways.	6.4 cm 2.5 in.	15.2 cm. 6 in.
Power lines enclosed in grounded conduit.	5.0 cm 2.0 in.	7.6 cm. 3 in.
Transformers and electric motors.	1.02 m 40 in.	
Fluorescent lights.	30.5 cm 12 in.	

.7 When terminating cables, the length of cable twist (twist/cm) shall be identical to that of the remainder of the cable. This twist shall be maintained up to 10 mm from the termination point of the cable at the patch panel and the receptacle.

.8 UTP Cable Terminations

.1 Terminate UTP cables at the work area outlet with an RJ 45 female connector.

.2 The cable colour code/jack pin assignments shall match (TIA jack-pin pair assignment) T568A.

.3 Terminate data cables directly to RJ-45 patch panels on equipment racks at the communications closet end and, connected to data hubs via patch chords.

.4 Maximum untwisted length of conductors shall not exceed 12mm (0.5 inch).

.9 Identify each cable with a permanent indelible identification band which indicates the room and outlet number to which the cable is connected. Both ends of each cable must have identical identifier bands.

.10 Identify each communication outlet with a permanent indelible label using standard numbering scheme.

.11 Identify each patch panel position with the room and outlet number to which the cable is connected.

3.2 Acceptable Testing and Certification

.1 Category 6A performance tests shall be in accordance with ANSI/TIA-568-B.2-10-2008 and must be performed with the wall plates in place.

.2 Augmented Category 6A system testing.

.1 For connecting hardware with modular interface components (i.e. Plug and jack connectors) transmissions tests shall be performed with both components in a mated state on all 4 pairs, and shall meet the following performance criteria

PSANEXT	70 dB @ 100 MHz
Insertion Loss	0.2 dB @ 100 MHz 0.45 dB @ 100 MHz
Return loss	28 dB @ 100 MHz
TCL	34 dB @ 100 MHz
NEXT	54 dB @ 100 MHz 40 dB @ 500 MHz

.2 At a minimum, the balanced twisted-pair cabling system will exceed the key performance parameters for Augmented Category 6A found in ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100* Ω

Augmented Category 6 Cabling over the specified frequency ranges by the values listed below.

Parameter	**Worst Case Margin (1 – 500 MHz)**	**Worst Case Margin (500 – 625 MHz)**
Insertion loss	3%	Beyond Standard (*)
Return loss	2.0 dB	Beyond Standard (*)
NEXT	2.5 dB	Beyond Standard (*)
PSNEXT	3.5 dB	1.5 dB(*)
PSANEXT	2.0 dB	2.0 dB(*)
PSACRF	10.0 dB	8.0 dB(*)
PSAACRF	Beyond Standard	Beyond Standard (*)

NOTE: The **Margin** is the additional headroom (in dB or %) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range. The **Worst Case Margin** is determined at the frequency where the measured data point is closest to the limit line. The Category 6A limit line equations are used to determine the **Worst Case Margin** over the frequency range from 500 MHz to 625 MHz.

NEXT = Near-end crosstalk

PSACRF = Power-sum attenuation-to-crosstalk ratio far-end

PSAACRF = Power-sum alien attenuation-to-crosstalk ratio far-end

PSANEXT = Power-sum alien near-end crosstalk

PSNEXT = Power-sum near-end crosstalk

NOTE: The values listed above are characterized as “Margin” or “Guaranteed Headroom” beyond the performance specified in standards, and serve as additional assurance of the cabling system’s performance after installation and over its operational lifespan.

(*) Value proposed or statement represent guaranteed margin against ANSI/TIA-568-B.2-10-2008 – *Transmission Performance Specifications for 4-pair 100* Ω *Augmented Category 6 Cabling* extrapolated to 625MHz.

.3 Certification

.1 Certify that all cabling and hardware meets the performance criteria in this specification and is free from any optical, electrical or mechanical defects as a result of the installation and termination practices for a period of twenty-five (25) years from the time of acceptance by the Owner.

.2 Provide two (2) copies of all installation documentation and reports. The minimum documentation set shall include:

.1 As-built drawings in paper format, fully documenting the cabling infrastructure. Copies of the approved drawings in AutoCAD “DWG” format shall be provided by the Owner to form a basis for as-built drawings.

.2 Records of all test procedures and test results in a report format and detailed test results including graphical data in an electronic format.

.4 Upon completion of the Work, the Engineer shall carry out an onsite final inspection.

As a minimum, the following points will be examined:

.1 Is the design documentation complete? Are all cables properly labelled, from end-to-end?

.2 Have all terminated cables been properly tested in accordance with the specifications for the specific category as well as tested for opens, shorts, polarity reversals, transposition and presence of AC and /or DC voltage?

.3 Is the cable type suitable for its pathway? Are the cables bundled in parallel?

.4 Have the pathways manufacturer’s guidelines been followed? Are all cable penetrations installed properly and fire stopped according to code?

.5 Have the Contractors avoided excessive cable bending?

.6 Have potential EMI and RFI sources been considered?

.7 Are conduit cable fills correct?

.8 Are hanging supports within 1.5 meters (5 feet)?

.9 Does hanging cable exhibit some sag?

.10 Are telecommunications closet terminations compatible with applications equipment?

.11 Have patch panel instructions been followed?

.1 Jacket removal point.

.2 Termination positions.

.3 All pair terminations tight with minimal pair distortions.

.4 Twists maintained up to Index Strip.

.12 Have modular panel instructions been followed?

.1 Cable dressing first.

.2 Jackets remain up to the Connecting Block.

.3 All pair terminations tight and undistorted.

.4 Twists maintained up to the Connecting Block.

.13 Are the correct outlet connectors used?

.14 Is the jacket maintained right up to the jack?

.15 Are all pairs tightly twisted and straight across in the Panel?

.16 Are identification markings uniform, permanent and readable?

END OF SECTION

1. General

1.1 System Description

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, conduits, cabletroughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

.2 Cabletrough distribution system.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Material

.1 Conduits, Conduit Fastenings and Conduit Fittings Section 26 05 33

.2 Cabletrays Section 26 05 36 12

.3 Wireways and Auxiliary Gutters. Section 26 05 36 13

.4 STI EZ Path for wall and floor penetrations to allow for full capacity of tray.

.5 Splitters, Junction, Pull Boxes and Cabinets Section 26 05 31

3. Execution

3.1 Installation

.1 Firestop all wall, ceiling and floor penetrations.

.2 Install raceway system, including overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletroughs; raceways, service poles, miscellaneous and positioning material to constitute complete system.

END OF SECTION

1. General

1.1 SCOPE

.1 This section describes audio paging systems and items that are commonly required for the proper operation and installation as specified in Division 27.

This section shall be read together with the sections describing specific systems, components and the manufacture, installation, operation and maintenance thereof.

Where a discrepancy is noted between the various sections, notify the consultant for an interpretation. In the absence of written clarification, the consultant will assume that the most expensive solutions are applicable for use on the projects.

1.2 GENERAL REQUIREMENTS

.1 Provide complete multi-zone paging system accessed by telephone system as described herein and as shown on drawings.

.2 System to be complete with all necessary components to provide functions required whether or not each and every item is necessarily mentioned. All components to be production proven models. Custom designed units will only be considered for those items that are not currently available on commercial market. System to be supplied and installed by an established communications contracting firm that is approved by the Consultants.

.3 Selection of system to be made on the basis of quality and suitability of equipment, service facilities, and past performance of contracting firm.

.4 Correct work completed contrary to the intent of the drawings and specifications and bear all costs for same. Where intent of the drawings and specifications is not clear, obtain clarification from the Owner before proceeding with work. Provide prompt installation of work when coordinating with other trades as in advance of concrete pouring or similar work. Provide sleeves and locate them for contractor.

.5 Where equipment supplied by Division 27 must be built-in with work of other trades, supply equipment to be built-in or measurements to allow necessary openings to be left so as not to hold up work.

.6 Before proceeding with installation, successful system installer to submit to Consultant for approval a complete detailed proposal as outlined in Clause 1.3, Shop Drawings.

.7 All materials, equipment, devices, components, wire and cable provided under this contract shall be new CSA approved and listed with ULC as required by code authorities.

1.3 SHOP DRAWINGS

.1 Submit shop drawings for all Division 27 systems and components in the format as specified in Section 28 33 23.

1.4 OPERATING MANUALS

.1 Operating manuals to be furnished as specified in Section 28 78 23.13.

1.5 STAFF QUALIFICATIONS

.1 Supply minimum of one (1) staff member currently qualified as holder of the Certified Technology Specialist (CTS) designation or higher as provided by InfoComm International. Refer to Section 28 33 13 Certificates.

1.6 COORDINATION

.1 Coordinate all work with the other trades for scheduling, rough-in, and finishing all work specified.

.2 The Owner will not be liable for any additional costs as a result of missed dates or poor coordination of the supplying contractor with other trades.

1.7 REFERENCES

.1 ANSI/INFOCOMM 10:2013 - *Audiovisual Systems Performance Verification.*

.2 CAN-CSA C22.1-15 *Canadian Electrical Code Part 1 23rd Ed.*

2. ProductsGENERAL

.1 Provide CSA approved products capable of performing as specified.

.2 Where CSA certified equipment and material is not available, submit alternate equipment and material to authority having jurisdiction for special approval before delivery to site. Provide information on alternate items submitted for approval to Consultant in accordance with Section 28 33 23 Shop Drawings, Product Data, and Samples except where items are specified as ‘no alternates’.

2.2 PAGING CONTROLLER

.1 Supply, install and configure one (1) multi-zone paging controller as indicated on drawings and as described herein.

.2 Paging controller to include:

.1 Modular design,

.2 Power On LED indicator,

.3 Universal analog telephone interface unit for direct connection to PBX or Key paging ports with DTMF capability,

.4 Field programming function using DTMF,

.5 All page override,

.6 Central processor unit,

.7 Minimum of four paging zones,

.8 Wall mounting kit,

.9 Power supply.

.3 Paging control unit to be Bogen PCS-2000 or approved equal.

2.3 CEILING RECESSED PAGING SPEAKERS

.1 Provide, install, configure and test ceiling mounted paging speakers as shown on drawings and as described herein.

.2 Ceiling recessed speaker to include:

.1 Cone design with 8 inch (or larger) metal speaker assembly and permanently mounted magnet.

.2 White in color baffle with grille and metal back can. Confirm color with Consultant prior to ordering.

.3 Manufacturer supplied ceiling tile bridge or support where speakers are installed in T-bar grid ceilings.

.4 Multi-tap adjustment including 10, 6, 4, 2, 1, ½ watt settings.

.5 Speaker rating minimum 15 watts continuous program.

.6 10 watt low loss transformer.

.7 Sensitivity of 89dB SPL or better, 1 watt @ 1 meter.

.8 Frequency response (-3dB): 70Hz – 20 kHz or better

.3 Standard of Acceptance: Enforcer E810CWT10TRA, or approved equal.

2.4 MULTI-ZONE PAGING AMPLIFIER

.1 Supply, install and configure multi-zone paging amplifier(s) as indicated on drawings.

.2 Paging amplifiers to include:

- .1 Minimum 4 channel design.
- .2 70v Output per channel.
- .3 One Input per output channel.
- .4 Minimum 15 watt output per channel.
- .5 Wall or Rack mount kit.

.3 Standard of Acceptance: TOA DA series, or Bogen TPU series, or approved equal.

.4 Where existing speakers are to be re-used, confirm condition of speakers by conducting a frequency sweep 40Hz to 21kHz and inform Owner of any issues noted.

3.1 GENERAL

.1 Supply, set-up/install, and test the complete audio communication systems as indicated herein.

.2 Set-up/Install includes:

- .1 Unbox and connect components, install all required device interfaces, and cabling required.
- .2 Removal or disabling of Guest passwords and accounts for programmable equipment.
- .3 Removal of all boxes and packaging.
- .4 Turnover of all manufacturer supplied computer accessories, manuals, software, discs, and materials to the Owner. Refer to Section 28 78 23.13.
- .5 Installation, configuration and programming of all system equipment and components.

.3 Follow equipment manufacturers recommendations for equipment installation, programming and set-up.

3.2 SPEAKERS

.1 Install speakers using manufacturer supplied tile bridge or support.

.2 Connect new speakers to new audio amplifier(s).

.3 Set speaker tap settings for optimal sound level in each coverage area.

.4 Match speaker tap settings for uniform sound level across the coverage area.

3.3 PAGING CONTROLLER

.1 Install controller equipment and complete any required interconnection of equipment to make system functional.

.2 Complete connections to telephone system paging port and contact closures (if used) as required for system operation.

.3 Configure system for minimum of four (4) zone paging plus all-call to activate all zones simultaneously from telephone paging port inputs using DTMF tones.

.4 Adjust pre-announce tone as required.

3.4 PAGING AMPLIFIERS

.1 Measure and record impedance value for each speaker circuit prior to connecting speaker circuits to amplifier outputs.

.2 Install paging amplifiers on wall or in rack as required.

.3 Set volume level for each zone.

3.5 RECORD DRAWINGS, MANUALS AND PROJECT CLOSE-OUT

.1 Submit operating instructions and red line drawings to the engineer.

END OF SECTION

1. General

1.1 System Description

.1 The electrical contractor shall provide the security raceway system which will consists of outlet boxes, cover plates, conduits, cabletroughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings.

1.2 Waste Management and Disposal

.1 Refer to Section 26 05 00 11 – Electrical General Requirements.

2. Products

2.1 Material

.1 Conduits, Conduit Fastenings and Conduit Fittings Section 26 05 33

.2 Cabletrays Section 26 05 36 12

.3 Wireways and Auxiliary Gutters. Section 26 05 36 13

.4 Splitters, Junction, Pull Boxes and Cabinets Section 26 05 31

3. Execution

3.1 Installation

.1 Firestop all wall, floor and ceiling penetrations.

.2 Install raceway system, including overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletrays; raceways, service poles, miscellaneous and positioning material to constitute complete raceway system.

.3 Raceway system to be coordinated with supplier of security system components.

END OF SECTION

1. GENERAL

1.1 Related Work

.1 Conduits, Conduit Fastenings and Conduit Fittings:

.2 Wires and Cables 0-1000V:

1.2 References

.1 CAN/ULC-S524, Installation of Fire Alarm Systems.

.2 ULC-S525, Audible Signal Appliances for Fire Alarm.

.3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527, Control Units, Fire Alarm.

.5 CAN/ULC-S528, Manual Pull Stations.

.6 CAN/ULC-S529, Smoke Detectors, Fire Alarm.

.7 CAN/ULC-S530, Heat Actuated Fire Detectors, Fire Alarm.

.8 CAN/ULC-S531, Smoke Alarms.

.9 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.

.10 CAN/ULC-S537, Verification of Fire Alarm Systems.

.11 NBC, National Building Code of Canada.

1.3 System Description

.1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.

.2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general/ single stage alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.

.3 Zoned, non-coded single stage.

.4 Modular in design to allow for future expansion.

.5 Operation of system shall not require personnel with special computer skills.

.6 System to include:

.1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.

.2 Power supplies.

.3 Initiating/input circuits.

.4 Output circuits.

.5 Auxiliary circuits.

.6 Wiring.

.7 Manual and automatic initiating devices.

.8 Audible and visual signalling devices.

.9 End-of-line resistors.

.10 Local and Remote annunciators.

.11 Printer Event log memory chip.

.12 Historic event recorder.

1.4 Requirements of Regulatory Agencies

.1 System components: listed by ULC and comply with applicable provisions of Alberta Building Code, Local Building Code, and meet requirements of the RCMP and local authority having jurisdiction.

1.5 Shop Drawings

.1 Submit shop drawings in accordance with Electrical General Requirements.

.2 Include:

.1 Detail assembly and internal wiring diagrams for control unit

.2 Overall system riser wiring diagram identifying control equipment initiating devices, signalling circuits; identifying terminations, terminal numbers, conductors and raceways.

.3 Details for devices.

.4 Details and performance specifications for control, annunciation and peripherals with item by item cross reference to specification for compliance.

.5 Step-by-step operating sequence, cross referenced to logic flow diagram.

1.6 Operation and Maintenance Data

.1 Provide operation and maintenance data for fire alarm system for incorporation into manual specified in Electrical General Requirements.

.2 Include:

.1 Instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Technical data - illustrated parts lists with parts catalogue numbers.

.3 Copy of approved shop drawings with corrections completed and marks removed except review stamps.

.4 List of recommended spare parts for system.

1.7 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 - Maintenance Materials, Special Tool and Spare Parts.

.2 Include:

.1 6 spare glass rods for manual pull box stations.

1.8 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 Owner or the Owner’s Representative.

.2 Include in tender price temporary program changes during construction period, and final programming prior to occupancy including zone labels, control functions, system operation, device identification and system adjustments.

1.9 Training

.1 Provide on-site lectures and demonstration by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

1.10 Waste Management and Disposal

.1 Refer to LEED documentation if applicable.

2. PRODUCT

2.1 Materials

.1 Equipment and devices: ULC listed and labeled and supplied by single manufacturer.

.2 Power supply: to CAN/ULC-S524.

.3 Audible signal devices: to ULC-S525.

.4 Visual signal devices: to CAN/ULC-S526.

.5 Control unit: to CAN/ULC-S527.

.6 Manual pull stations: to CAN/ULC-S528.

.7 Thermal detectors: to CAN/ULC-S530.

.8 Smoke detectors: to CAN/ULC-S529.

.9 Smoke alarms: to CAN/ULC-S531.

2.2 System Operation: Single Stage

.1 Actuation of any alarm initiating device to:

- .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder.
- .2 Indicate zone of alarm at central control unit and at remote annunciator.
- .3 Cause audible signalling devices to sound in alarm tone throughout building.
- .4 Transmit signal to fire department via central station and or the monitoring agent selected by the owner.
- .5 Cause air conditioning and ventilation fans to shut down.

.2 Acknowledging alarm: indicated at central control unit.

.3 Silence signals by "alarm silence" switch at central control unit only after a 60 second period of operation.

.4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

.5 Actuation of any supervisory device to:

- .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
- .2 Indicate respective supervisory zone at central control unit and remote annunciator.
- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.

.6 Resetting alarm/ supervisory device not to return system indications/functions back to normal until control unit is reset.

.7 Trouble on system to:

- .1 Indicate circuit in trouble at central control unit.
- .2 Activate "system trouble" indication, buzzer and common trouble sequence. Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.

.8 Troubles on system: suppressed during course of alarm.

.9 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel

.1 General: Comply with ULC-S527, "Control Units for Fire Alarm Systems."

.2 The following FACP hardware shall be provided:

.1 Base panel 120 VAC input power.

.2 1,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).

.3 1,000 points of Network Annunciation at FACP Display when applied as a Network Node

.4 1000 points of annunciation where one (1) point of annunciation equals:

.1 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.

.2 1 LED on panel or 1 switch on panel.

.5 From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.

.6 Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output .

.7 One Auxiliary electronically resetable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.

.8 One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.

.9 Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.

.10 Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.

.11 Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.

.12 The FACP shall support (6) RS-232-C ports and one service port.

.13 Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.

.14 Modular Network Communications Card.

.15 Service Port Modem for dial in passcode access to all fire control panel information.

2.4 Power Supplies

.1 120 V, 60 Hz as primary source of power for system.

.2 Voltage regulated, current limited distributed system power.

.3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.

.4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.

.5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.

.6 Standby batteries: sealed, maintenance free.

.7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.5 Initiating/Input Circuits

.1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, heat detectors and water flow switches.

.2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.

.3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".

.4 Receiving circuits for supervisory, N/O devices. Devices.

.5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

2.6 Alarm Output Circuits

.1 Alarm output circuit: connected to signals, wired in class A configuration to central control unit and DGPs/transponders.

   .1 Signal circuits' operation to follow system programming; capable of sounding alarms and driving visuals.

   .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.7 Auxiliary Circuits

.1 Auxiliary contacts for control functions.

.2 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.

.3 Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.

2.8 Wiring

.1 Twisted copper conductors: rated 600 V.

.2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.

.3 To signal circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

.4 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.

2.9 Manual Alarm Stations

.1 Manual alarm stations: pull lever, glass rod, wall mounted semi-flush type, non-coded single pole normally open contact for single stage Bilingual signage. Electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.10 Automatic Alarm Initiating Devices

.1 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57 & 88°C, rate of rise 8.3 °C per minute.

.1 Electronics to communicate detector's status to addressable module/transponder.

.2 Detector address to be set on detector in field.

.2 Smoke detector: ionization, photo-electric type and air duct type with sampling tubes with protective housing.

.1 Twistlock Plug-in type with fixed base.

.2 Wire-in base assembly with integral red alarm LED,

.3 Addressable smoke detector

.4 Ionization and Photo-electric type.

.5 Electronics to communicate detector's status to addressable module/transponder.

.6 Detector address to be set on detector in field.

2.11 Combination Audible Visual Signal Devices

.1 Horn Strobes: Designed for surface mounting on walls and or ceilings. Backboxes shall be flush with concealed conduit

.2 Visual Signal Device: 24 V dc, xenon with intensity selection of 15, 30, 75 or 110 candela. . Synchronize all visual alarm units in a temporal pattern

.3 Horns: 24 V dc, temporal or 60 BPM March Time Pattern.

.4 Audible and Visual Devices to be wired Class A.

2.12 Visual Alarm Signal Devices

.1 Strobe Only: 24 V dc, xenon with intensity selection of 15, 30, 75 or 110 candela. .

.2 Synchronize all visual alarm units in a temporal pattern. Wired as Class A.

2.13 End-of-Line Devices

.1 End-of-line devices to control supervisory current in alarm circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.14 Remote Annunciators

.1 LED type, with designation cards to indicate zones.

.2 Display:

  .1 Alarms and troubles for alarm initiating circuits.

  .2 Supervisory alarms and troubles common supervisory alarm for supervisory initiating circuits.

  .3 Common system trouble.

.3 Trouble buzzer

  .1 Acknowledging trouble at main panel to silence trouble buzzers in system.

.4 Supervised, with LED test button.

2.15 As-Built Riser Diagram

.1 Fire alarm system riser diagram: in glazed frame minimum size 600 x 600 mm mounted in security office.

2.16 Ancillary Devices

.1 Remote relay unit to initiate fan shutdown.

3. EXECUTION

3.1 Installation

.1 Install systems in accordance with CAN/ULC-S524.

.2 Install central control unit and connect to ac power supply, ac standby power.

.3 Install manual alarm stations and connect to alarm circuit wiring.

.4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to main control panel.

.6 Install signal horns and visual signal devices and connect to signalling circuits.

.7 Connect signalling circuits to main control panel.

.8 Install end-of-line devices at end of alarm initiating circuits.

.9 Install remote annunciator panel and connect to annunciator circuit wiring.

.10 Install door releasing devices.

.11 Install remote relay units to control fan shut down.

.12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.

.13 Splices are not permitted.

.14 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment as required by equipment manufacturer.

.15 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.

.16 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

3.2 Field Quality Control

.1 Perform verification test in accordance with CAN/ULC-S537. Pretest for verification with system manufacturer and complete all items in “Fire Alarm Pre Verification checksheet” below, then submit Fire Alarm Pre Verification checksheet to Engineer to book time for Verification. Coordinate with RCMP to ensure monitoring agreement is in place with monitoring agency. Fire alarm system must be 100% operational before bringing in Engineer for verification

.2 Electrical Contractor shall allow as a cash allowance, the sum of $4000.00 for the electrical engineer's portion of the verification.

FIRE ALARM PRE VERIFICATION CHECKSHEET - COMPLETE AND RETURN TO THE CONSULTANT

		YES	NO	N/A
1.0	**GENERAL**			
.1	Has the building been cleaned	☐	☐	☐
.2	Have the PPE requirements been removed	☐	☐	☐
.3	Is the building ready for occupancy	☐	☐	☐
.4	Has the system been pre-verified	☐	☐	☐
.5	Have you tested the horn/strobes	☐	☐	☐
.6	Is the panel clear of all Grounds	☐	☐	☐
.7	Is the Panel clear of all troubles (excluding overrides i.e. elevator homing, bells, sprinkler tamper switches)	☐	☐	☐
.8	Will the crew that installed the system be Present for the FAVI	☐	☐	☐
.9	Is the Sprinkler System 100% complete filled with water and the valves open	☐	☐	☐

		YES	NO	N/A
2.0	**INSTALLATION**			
.1	Do you have stranded wire at the horn/strobes	☐	☐	☐
.2	Are all the devices away from their mounting location, ready for the verification	☐	☐	☐
.3	Is the final device mounting crew here	☐	☐	☐
.4	Is the breaker red and locked off or ready to be locked off	☐	☐	☐
.5	Are the lamacoids /Labeling complete	☐	☐	☐
.6	Have you checked the voltages at the EOL's	☐	☐	☐
.7	Have you confirmed the settings for all the horn/strobes	☐	☐	☐
.8	Do we have access to all devices	☐	☐	☐
.9	Do you have an LED for Duct Detectors	☐	☐	☐
.10	Is the sprinkler tree ready and has it been pre-tested	☐	☐	☐
.11	Has the Pre-AC system been tested	☐	☐	☐
.12	Is the interface to Building Automation System completed and tested	☐	☐	☐
.13	Is all door hardware installed and tested	☐	☐	☐
3.0	**TECHNICIANS**			
.1	Is the system programmer here	☐	☐	☐
.2	Do you have a print out (hard copy) of all the points	☐	☐	☐
.3	Is the programming 100% complete	☐	☐	☐

		YES	NO	N/A
.4	Do we have field communication everywhere (radios/phones)	☐	☐	☐
.5	Have the descriptors been pre-approved by the owner	☐	☐	☐
.6	Do you have the as-builts for the ISO's	☐	☐	☐
.7	Do you know the sequence of operation for all the output relays (ancillary devices)	☐	☐	☐

4.0 FINAL

		YES	NO	N/A
.1	Is the system ready to be handed over to the owner	☐	☐	☐
.2	Will the owner be responding to panel troubles	☐	☐	☐
.3	Has the bell ring been coordinated with the owner	☐	☐	☐
.4	Have the Vesda/s been pre-verified	☐	☐	☐
.5	Has the call out been pre-verified	☐	☐	☐
.6	Has the owner been advised of the Verification	☐	☐	☐ and will he
	be attending the verification ☐ ☐	☐		
.7	Do you have a Plan and a Contingency Plan for this verification.	☐	☐	☐

Stantec Consulting Ltd.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C127-15, Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
- .2 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
- .3 ASTM D1557-12e1, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
- .4 ASTM D4253-14, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.3 DEFINITIONS

.1 Corrected maximum dry density is defined as:

- .1 D =
- .2 D = (F1 x D1) + (0.9 x D2 x F2)
- .3 Where: D = corrected maximum dry density kg/m^3.
  - .1 F1 = fraction (decimal) of total field sample passing [19] [4.75] mm sieve
  - .2 F2 = fraction (decimal) of total field sample retained on [19] [4.75] mm sieve (equal to 1.00 - F1)
  - .3 D1 = maximum dry density, kg/$m^3$of material passing   mm sieve determined in accordance with Method   of .
  - .4 D2 = bulk density, kg/m^3, of material retained on   mm sieve, equal to 1000G where G is bulk specific gravity (dry basis) of material when tested to ASTM C127.
- .4 For free draining aggregates, determine D1 (maximum dry density) to ASTM D4253 dry method when directed by Departmental Representative.

2 Products

2.1 NOT USED

.1 Not Used.

3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for clearing the site, the designated working area and the designated storage area.

.2 The following work is included:

- Cutting trees and brush.
- Salvage of usable timber.
- Preservation of trees and brush where required.
- Grubbing roots and stumps.
- Burning or disposal of waste.
- Removal of grass, weeds, concrete, fences and other deleterious material.
- Cleanup of debris.

1.2 REGULATIONS

.1 Abide by laws and regulations of the Province, and Municipality in which the work is located, particularly with regard to fire regulations and public safety.

.2 Observe regulations of the Alberta Forest Service.

.3 Obtain all permits to burn waste and debris from Alberta Forest Service and/or the Municipality, and abide by the stipulations of the permits.

1.3 AREA TO BE CLEARED

.1 Areas to be cleared are shown on the drawings.

.2 Clearing shall not exceed the limits of rights-of-way, permanent easements and working easements.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 CLEARING

.1 Cut, remove, and dispose of all timber, brush, windfall and any other fallen timber, stumps and rubbish except such trees and shrubs as may be designated for preservation by the Engineer.

.2 Preserve such designated trees and shrubs from scarring, barking or other injury during construction operations.

.3 Where grubbing is not to be done, all trees, roots and existing stumps shall be cut off flush with the original ground surface.

.4 Cut, remove and dispose of dangerous trees overhanging and off the right-of-way.

.5 Pull down, remove and dispose of any structures, fences and any physical obstructions.

3.2 SALVAGE

.1 Remove merchantable timber as defined by the Alberta Forest Service.

.2 Merchantable timber, in general, includes trees with a bottom diameter of 150 mm or greater and a top diameter of 100 mm or greater.

.3 All timber or materials salvaged shall be the property of the Owner.

.4 The Engineer will designate trees to be salvaged. Trim branches from salvaged timber, cut into 3 m lengths and pile neatly in stockpiles.

.5 Dispose of branches and debris.

3.3 GRUBBING

.1 Excavate, remove and dispose of all roots, stumps, submerged logs, corduroy and similar objectionable matter, to a minimum depth of 0.3 m.

.2 Fill holes and level areas disturbed by grubbing.

3.4 DISPOSAL

.1 In areas shown on the plans or designated by the Engineer for clearing and grubbing, all timber, logs, trees, stumps, brush and other rubbish must be disposed of as follows:

i) Pile and burn in accordance with the permit and prevailing local regulations, if the regulations permit burning.

ii) Remove all waste materials from the site and dispose of waste material at a site obtained by the Contractor.

.2 Pile and burn only in areas designated by the Engineer.

3.5 FINISH

.1 Leave ground surface in a condition suitable for stripping of topsoil.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for stripping of topsoil and organic material from the site.

.2 The work includes:

- Stripping and hauling to disposal.

- Stripping and stockpiling for re-use.

1.2 RELATED WORK

.1 Clearing - Section 31 11 00.

.2 Grading - Section 31 22 16.

1.3 REGULATIONS

.1 Abide by provincial and municipal regulations with regard to stream crossings, diversions or alterations to drainage patterns.

1.4 LIMITS

.1 Stripping width shall be to limits shown on the drawings.

.2 Stripping width for pipelines shall be the full width of the trench, plus the width of area to be used for spoil piles and the width of working areas.

.3 The Engineer may order specific areas to be stripped; and the width of stripping for pipeline construction shall be acceptable to the Engineer.

.4 The Engineer may waive stripping of wet land areas, at his discretion.

.5 If the topsoil is frozen strip the area over the trench and only other areas designated by the Engineer.

PART 2 - PRODUCTS

NOT APPLICABLE

PART 3 - EXECUTION

3.1 NOTIFICATION

.1 The Contractor shall notify the Engineer in writing, a minimum of 3 working days prior to commencement of stripping.

.2 The Engineer and the Contractor shall inspect the area to be stripped to establish specific requirements and to review procedures, which shall be confirmed in writing by the Contractor.

3.2 STRIPPING AND STOCKPILING

.1 Load, haul and place in stockpiles in the designated areas.

.2 Stockpile in a manner that will not endanger persons, the work or adjacent property.

.3 Keep topsoil stockpiles separate and do not mix with common excavation.

.4 Maintain a minimum of 1 m separation between topsoil and common excavation material when piling.

.5 Leave openings in stockpiles so that fields are accessible to Owners.

3.3 STRIPPING AND DISPOSAL

.1 Strip organic material that will not be re-used.

.2 Strip unsuitable material.

.3 Load, haul and dispose of stripped material.

3.4 DISPOSAL AREAS

.1 Disposal areas shall be as shown on the drawings or as marked in the field by the Engineer.

.2 Grade the disposal areas to provide adequate drainage.

3.5 STRIPPING FROZEN TOPSOIL

.1 Frozen topsoil may be stripped by ripping provided a minimum of 2 passes are made, the first of which shall not exceed 50% of the topsoil depth.

3.6 MIXING

.1 If the topsoil and subsoil are mixed and the topsoil is adversely affected, the Contractor shall, at his own expense, engage a soils specialist to determine the necessary remedial work, and shall perform the required work.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 31 05 10 Corrected Maximum Dry Density for Fill

.2 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 ASTM International
  .1 ASTM D698-12e2, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m^3).

1.3 EXISTING CONDITIONS

.1 Examine subsurface investigation report which is available for inspection as specified in Section 00 31 32.

.2 Known underground and surface utility lines and buried objects are as indicated on site plan.

.3 Refer to dewatering in Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2 Products

2.1 MATERIALS

.1 Fill material: in accordance with of Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Excavated or graded material existing on site suitable to use as fill for grading work if approved by Departmental Representative.

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 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 CLEARING

.1 Remove all vegetation within the building area as directed by the Departmental Representative. Remove cut waste material from site. Where applicable, grub out stumps and roots. Do not bury cuttings, stumps, roots or burnt waste materials.

.2 Do not pull or rip out roots of trees that are to remain. If excavation through roots is required, excavate by hand and cut roots with sharp axe.

.3 Remove broken or dead branches which constitute a hazard to safety. Make clean, smooth, sloping cuts and apply tree paint to wounds.

.4 Remove all grass, shrubs, bushes, weeds and the like.

3.3 STRIPPING OF TOPSOIL

.1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined by Departmental Representative.

.2 Commence topsoil stripping of areas as indicated, after area has been cleared of brush, weeds, grasses and removed from site.

.3 Strip topsoil down to subsoil as directed by Departmental Representative. Rototill and retain as topsoil on site. Avoid mixing topsoil with subsoil.

.4 Stockpile in locations as directed by Departmental Representative. Stockpile height not to exceed 2 m.

.5 Dispose of unused topsoil off site as directed by Departmental Representative.

3.4 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.
.2 450 mm for flowerbeds.
.3 450 mm for shrub beds.
.4 400 mm for asphalt paving.
.5 300 mm for concrete paving and walks.

.3 Slope rough grade away from building as indicated or as otherwise directed.

.4 Grade ditches to depth required for maximum run-off as indicated.

.5 Prior to placing fill over existing ground, scarify surface to depth of 300 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 corrected maximum dry density to ASTM D698, as follows:
  .1 95% under landscaped areas.
  .2 98% under paved and walk areas.

.7 Do not disturb soil within branch spread of trees or shrubs to remain.

3.5 TESTING

.1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid by Departmental Representative in accordance with Sections 01 29 83 - Payment Procedures for Testing Laboratory Services and 01 45 00 - Quality Control.

.2 Submit testing procedure, frequency of tests, testing laboratory as designated by ULC or certified testing personnel to Departmental Representative for review.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  .1 Leave Work area clean at end of each day.

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

3.7 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

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 05 10 - Corrected Maximum Dry Density for Fill

.2 Section 31 22 13 - Rough Grading

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C117-13: Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
- .2 ASTM C127-15: Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
- .3 ASTM C136/C136M-14: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .4 ASTM D422-63(2007)e2: Standard Test Method for Particle Size Analysis of Soil.
- .5 ASTM D698-12e2: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
- .6 ASTM D1557-12e1: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).
- .7 ASTM D2167-15: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- .8 ASTM D4253-14: Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- .9 ASTM D4318-10e1: Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .10 ASTM D6938-15: Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

.2 Canadian Standards Association (CSA) Standards:
- .1 CSA-A3000-13: Cementitious Materials Compendium.
- .2 CAN/CSA-A23.1-14/A23.2-14: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.3 CGSB Standards:
- .1 CAN/CGSB-8.1-88: Sieves, Testing, Woven Wire, Inch Series.
- .2 CAN/CGSB-8.2-M88: Sieves, Testing, Woven Wire, Metric.

.4 U.S. Environmental Protection Agency (EPA)/Office of Water:
- .1 EPA 832R92 (2005): Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 DEFINITIONS

.1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
  .1 Rock : solid material in excess of 1.00 m^3 and which cannot be removed by means of heavy duty mechanical excavating equipment with 0.95 to 1.15 m^3 bucket. Frozen material not classified as rock.
  .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.

.2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.

.3 Topsoil:
  .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
  .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.

.4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.

.5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.

.6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.

.7 Unsuitable materials:
  .1 Weak, chemically unstable, and compressible materials.
  .2 Frost susceptible materials:
    .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422: Sieve sizes to CAN/CGSB-8.1.
    .2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

    .3 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

.8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
  .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
  .2 Submit for review by Departmental Representative proposed dewatering and heave prevention methods as described in PART 3 of this Section.
  .3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
  .4 Submit to Departmental Representative written notice when bottom of excavation is reached.
  .5 Submit to Departmental Representative testing results as described in PART 3 of this Section.

.3 Preconstruction Submittals:
  .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
  .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance record from utility authority and location plan of relocated and abandoned services, as required.

.4 Samples:
  .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  .2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.
  .3 Submit 70 kg samples of type of fill specified including representative samples of excavated material.
  .4 Ship samples prepaid to Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.

1.5 QUALITY ASSURANCE

.1 Qualification Statement: submit proof of insurance coverage for professional liability and all other insurance as required by the Contract.

.2 Contractor’s Professional Engineer and Engineering Requirements:
  .1 Where the Contractor has engaged the services of a professional Engineer registered in the province of Alberta, submit proof that Work by the Engineer is included in Contractor’s insurance coverage and that the Engineer has adequate professional liability insurance coverage.
  .2 Submit design and supporting documents and data minimum two (2) weeks prior to commencement of the Work.
  .3 Submit design and supporting documents and data bearing the seal and signature of a qualified professional Engineer, registered in the province of Alberta.
  .4 Keep design and supporting documents and data on site.
  .5 Engage services of a qualified profession Engineer, registered in the province of Alberta, to design and inspect, temporary shoring, bracing and underpinning required for the Work.

.3 The testing agency appointed by the Departmental Representative will perform the testing specified or which the Departmental Representative directs to be done. The Contractor will pay cost of testing out of the Cash Allowance specified in Section 01 21 00.

.4 Testing to be performed by a CSA approved testing firm, and approved by the Departmental Representative. Forward all test results to the Departmental Representative immediately following the tests.

.5 Test fill before using it. Determine optimum moisture content and Standard Proctor Maximum Dry Density for each fill type. Do not use fill until testing is complete and acceptance for use has been given by the Departmental Representative.

.6 Determine field density in accordance with ASTM D2922. Test each lift of fill of volume more than 5 cubic metres. Notify the Departmental Representative in advance, so that additional testing can be ordered, prior to each occasion on which smaller quantities of fill will be placed.

.7 Remove, replace and retest at no expense to the Owner, materials failing to meet project specifications.

.8 Make tests at the following intervals:

.1 Excavated Foundation Bearing surfaces: When undisturbed surfaces at bottom of excavations are being prepared, make a series of 3 tests of surface for each 300 m^2 area.

.2 Fill under slabs on grade: Make three tests for every lift of compacted fill for each 200 m^2 area.

.3 Backfill to foundation walls and in trenches: Test each lift of compacted fill for each 30 m of wall and trench being backfilled.

.4 Fill below asphalt pavement: Make three tests for every lift of compacted fill for each 200 m^2 area.

.9 If tested density is below specified, rework the area and depth of backfill represented by failed test, after the soil moisture has been conditioned as necessary, and re-compact to specified density.

.10 It is the Contractor's responsibility to coordinate with the testing agency and to ensure that the specified number of tests are provided at the appropriate time. All costs associated with retesting for areas which did not meet the specified results are to be borne by the Contractor. The Contractor is to provide minimum of 24 hours notice to testing agency before tests are required.

.11 Health and Safety:

.1 Comply with construction occupational health and safety requirements in accordance with Section 01 35 29.06 - Health and Safety Requirements and with all Occupational Health and Safety Act requirements.

.12 Where applicable, obtain permits from authority having jurisdiction, for temporary diversion of water course.

1.6 EXISTING CONDITIONS

.1 Examine soil report specified in Section 00 31 32.

.2 Buried services:
  - .1 Before commencing work establish location of buried services on and adjacent to site.
  - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
  - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
  - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
  - .5 Prior to beginning excavation Work, notify applicable Departmental Representative and authorities having jurisdiction establish location and state of use of buried utilities and structures. Authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
  - .6 Confirm locations of buried utilities by careful test excavations.
  - .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
  - .8 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing.
  - .9 Record location of maintained, re-routed and abandoned underground lines.
  - .10 Confirm locations of recent excavations adjacent to area of excavation.

.3 Existing buildings and surface features:
  - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, pavement, survey bench marks and monuments which may be affected by Work.
  - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
  - .3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

2 Products

2.1 MATERIALS

.1 Fill Type 1 - Site-excavated soil: approved site-excavated material free of vegetation, organics or other deleterious matter; includes only site-excavated material removed by required or authorized excavation. Provide soil for general site grading and backfilling consisting of low to medium plastic inorganic clay or clean, well graded granular material free of particles larger than 150 mm. Do not use frozen soil for fill or backfill. Prepare site excavated fill as outlined in the Geotechnical Report.

.2 Fill Type 2 - Pit run gravel: Alberta Transportation Specification Designation 6, Class 80; Crushed, pit run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material and other deleterious materials. Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

Sieve Size (Tyler)	Percentage Passing
80 mm	100
50 mm	55 - 100
25 mm	38 - 100
16 mm	32 - 85
5 mm	20 - 65
315 µm	6 - 30
80 µm	2 - 10

i) Fill Type 3: Alberta Transportation Specification Designation 2, Class 25; Crushed 25 mm Crushed Gravel: 25 mm clean, angular crusher run natural stone, free from shale, clay, friable materials, roots, and vegetable matter. Gradations to be within limits specified when tested to ASTM C136 and ASTM C117, graded as follows.

Aggregate Size	**Percentage Passing (mm)**
25 mm	100
20 mm	82 - 97
16 mm	70 - 94
10 mm	52 - 79
5 mm	35 - 64
1.25 mm	18 - 43
630 µm	12 - 34
315 µm	8 - 26
160 µm	5 - 18
80 µm	2 - 10

.3 Fill type 4 - Course Sand: Ungraded inorganic, granular materials. Gradations to be within limits specified when tested to ASTM C136 and ASTM C117, graded as follows.

Aggregate Size	Percentage Passing (mm)
10 mm	100
4.75 mm	95 - 100
2.36 mm	80 - 100
1.18 mm	50 - 85
0.6 mm	25 - 60
0.30 mm	10 - 30
0.15 mm	2 - 10

.4 Fill type 5: unshrinkable fill: proportioned and mixed to provide:
  .1 Maximum compressive strength of 10 MPa at 28 days.
  .2 Maximum cement content of 25 kg/m; with 40% by volume GU.
  .3 Minimum strength of 0.07 MPa at 24 hours.
  .4 Concrete aggregates: conforming to CAN/CSA-A23.1/A23.2.
  .5 Cement: type GU.
  .6 Slump: 160 mm to 200 mm.

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. Comply with all requirements and regulations of the Federal Department of Fisheries and Oceans and of Alberta Environment and all other applicable regulations, with regards to sedimentation and erosion control measures. Provide the Departmental Representative with a sediment and erosion control plan and report.

.2 Construct, regularly inspect, maintain and repair as necessary, such facilities until such time that the risk of silt and deleterious materials entering the storm sewer drainage system for the construction phase has passed.

.3 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.4 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 SITE PREPARATION

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02 41 13 - Selective Site Demolition.

3.3 PREPARATION/PROTECTION

.1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.

.2 Keep excavations clean, free of standing water, and loose soil.

.3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.

.4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.

.5 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

.1 Refer to Section 31 22 13 - Rough Grading, for stripping of topsoil.

3.5 STOCKPILING

.1 Stockpile fill materials in areas designated by Departmental Representative.
  .1 Stockpile granular materials in manner to prevent segregation.

.2 Protect fill materials from contamination.

.3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 SHORING, BRACING AND UNDERPINNING

.1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 29.06 - Health and Safety Requirements.
  .1 Where conditions are unstable, Departmental Representative to verify and advise methods.

.2 Obtain permit from authority having jurisdiction for temporary diversion of water course.

.3 Construct temporary Works to depths, heights and locations as directed by Departmental Representative.

.4 During backfill operation:
  .1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.

.2 Do not remove bracing until backfilling has reached respective levels of such bracing.
.3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.

.5 When sheeting is required to remain in place, cut off tops at elevations as indicated.

.6 Upon completion of substructure construction:
.1 Remove shoring and bracing.
.2 Remove excess materials from site and restore watercourses as directed by Departmental Representative.

3.7 DEWATERING AND HEAVE PREVENTION

.1 Keep excavations free of water while Work is in progress.

.2 Provide for Departmental Representative's review, details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.

.3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
.1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.

.4 Protect open excavations against flooding and damage due to surface run-off.

.5 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures to collection or runoff areas and in manner not detrimental to public and private property, or portion of Work completed or under construction.
.1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

.6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.8 EXCAVATION

.1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.

.2 Excavate to lines, grades, elevations and dimensions as directed by Departmental Representative.

.3 Remove demolished items and debris and other obstructions encountered during excavation in accordance with Section 02 41 13 - Selective Site Demolition.

.4 Excavation must not interfere with bearing capacity of adjacent foundations.

.5 Do not disturb soil within branch spread of trees or shrubs that are to remain.
.1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

.6 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

.7 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.

.8 Restrict vehicle operations directly adjacent to open trenches.

.9 Dispose of surplus and unsuitable excavated material off site.

.10 Do not obstruct flow of surface drainage or natural watercourses.

.11 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.

.12 Notify Departmental Representative when bottom of excavation is reached.

.13 Obtain Departmental Representative approval of completed excavation.

.14 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.

.15 Correct unauthorized over-excavation as follows:
- .1 Fill under bearing surfaces, slabs on grade and footings with Fill Type 2 compacted to not less than 100% of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 - Corrected Maximum Dry Density for Fill.
- .2 Fill under other areas with either Fill Type 1 or Fill Type 2 fill compacted to not less than 98% of corrected Standard Proctor maximum dry density in accordance with Section 31 05 10 - Corrected Maximum Dry density.

.16 Hand trim, make firm and remove loose material and debris from excavations.
- .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

3.9 FILL TYPES AND COMPACTION

.1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities in accordance with Section 31 05 10 - Corrected Maximum Dry Density for Fill.
- .1 Exterior side of perimeter walls: use Type 1 or Type 2 fill to subgrade level. Compact to 98% of corrected maximum dry density.
- .2 Within building area: use Type 2 to underside of base course for floor slabs. Compact to 98% of corrected maximum dry density. Moisture content to be +/- 2% of optimum.
- .3 Under concrete slabs: provide 150 mm compacted thickness base course of Fill Type 3 to underside of slab. Compact base course to 98%.
- .4 Retaining walls: refer to Section 32 32 19 - Modular Retaining Walls

.5 Place unshrinkable fill in areas as indicated.

3.10 BEDDING AND SURROUND OF UNDERGROUND SERVICES

.1 Place and compact granular material for bedding and surround of underground services as specified in Division 33.

.2 Place bedding and surround material in unfrozen condition.

.3 Unless indicated otherwise, use Fill Type 4 for bedding and covering of pipes and conduits in trenches. Ensure that this material is placed to 300 mm over pipe or conduit and compacted to 98% Standard Proctor Maximum Dry Density.

.4 Fill remainder of trenches with Fill Type 1 or Fill Type 2 to top of subgrade elevation.

.5 Do not use heavy or driven compacting equipment. Use manual compactors only, to prevent damage to services.

3.11 BACKFILLING

.1 Do not proceed with backfilling operations until completion of following:
   - .1 Departmental Representative has inspected and approved installations.
   - .2 Departmental Representative has inspected and approved of construction below finish grade.
   - .3 Inspection, testing, approval, and recording location of underground utilities.
   - .4 Removal of concrete formwork.
   - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

.2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

.3 Do not use backfill material which is frozen or contains ice, snow or debris.

.4 Place backfill material in uniform layers not exceeding 300 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.

.5 Backfilling around installations:
   - .1 Place bedding and surround material as specified elsewhere.
   - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
   - .3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 1 m.
   - .4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
     - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative.
     - .2 If approved by Departmental Representative, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Departmental Representative.

.6 Place unshrinkable fill in areas as indicated.

.7 Consolidate and level unshrinkable fill with internal vibrators.

3.12 BASE PREPARATION

.1 Below asphalt paving and concrete slabs on grade, scarify the top 150 mm of exposed sugrade or base of excavation and moisture condition to 2% wet of Optimum Moisture Content. Compact to 98%.

.2 Proof-roll subgrades prior to placing fill over. If proof rolling reveals unsatisfactory undisturbed sub-base conditions, and the Departmental Representative directs additional work to be carried out, this will be administered as a change to the contract.

.3 Perform proof-rolling with a heavy (15 - 60 tonne) rubber tired roller having 4 wheels abreast on independent axles with high contact wheel pressure (550 to 1030 kPa (80 to 150 psi) inflation pressures). Alternatively, a loaded tandem dump truck may be used in lieu of the proof rolling equipment specified, providing the truce is loaded to approximately 1 tonnes per axle and minimum tire pressure of 550 kPa (80 psi) as directed by the Departmental Representative.

.4 Prior to placing fill under slabs on grade, compact existing subgrade to obtain same compaction as specified for fill.

.5 Prepare relatively impermeable subgrade surfaces below asphalt pavement and landscaped areas by trimming them to smooth sloped surfaces so that they drain to subgrade drains or natural drainage courses as indicated, and are free of any other undrained depressions capable of retaining water.

.6 Remove all loose, softened or disturbed material from surfaces on which footings are to be placed, immediately prior to concrete placement. Replace loose or disturbed material with crushed gravel or unshrinkable fill, as directed by the Departmental Representative.

3.13 RESTORATION

.1 Upon completion of Work, remove waste materials and debris, trim slopes, and correct defects as directed by Departmental Representative.

.2 Replace topsoil as directed by Departmental Representative.

.3 Reinstate lawns to elevation which existed before excavation.

.4 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.

.5 Clean and reinstate areas affected by Work as directed by Departmental Representative.

.6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.

.7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

.8 Remove all excess fill and topsoil materials from site.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies the requirements for rip rap for culverts, storm sewer outlets, hydraulic structures and slope protection in locations shown on the drawings.

.2 The work includes supply of material and placing of:

.1 Gravel filter layer

.2 Filter cloth

.3 Pre-cast concrete rip-rap

.4 Bagged concrete rip-rap

.5 Rock rip-rap

.6 Cement mortar.

1.2 RELATED WORK

.1 Earthworks and preparation of slopes is included in trenching, in grading and in lagoon or pond earthwork.

PART 2 - PRODUCTS

2.1 FILTER GRAVEL

.1 Uniformly graded between 40 mm sieve and 75 mm sieve with less than 10% finer than 40 mm.

2.2 FILTER CLOTH

.1 Non-woven polyester in accordance with CAN/CGSB 148.1-M85, 150 g/m^2 1.5 mm thickness, Nilex C14 or approved equivalent alternative.

2.3 PRECAST CONCRETE

.1 Use interlocking type concrete blocks.

.2 Concrete shall be 28 MPa.

.3 Minimum thickness of block 225 mm.

.4 Minimum weight of block 54 kg.

2.4 BAGGED CONCRETE

.1 Use burlap bags 0.03 to 0.05 m^3 capacity.

.2 Fill bags 2/3 full with concrete and staple shut to form a straight closure.

.3 Use 20 MPa concrete.

2.5 ROCK RAP RIP

.1 Use selected round durable rock not subject to deterioration by water or weathering. Rock shall be in accordance with the following classes.

.2 Class 1 - Nominal size 300 mm dia. or 36 kg

100% smaller than 450 mm or 136 kg

20% larger than 350 mm or 68 kg

50% larger than 300 mm or 36 kg

80% larger than 200 mm or 11 kg.

.3 Class 2 - Nominal size 500 mm dia. or 180 kg

100% smaller than 760 mm or 680 kg

20% larger than 600 mm or 318 kg

50% larger than 500 mm or 180 kg

80% larger than 300 mm or 36 kg.

.4 Class 3 - Nominal size 760 mm dia. or 680 kg

100% smaller than 1200 mm or 2250 kg

20% larger than 900 mm or 1200 kg

50% larger than 760 mm or 680 kg

80% larger than 500 mm or 180 kg.

2.6 CEMENT MORTAR

.1 Cement - to CAN/CSA-A5/A8/A362-M88 type 10.

.2 Sand - to CSA-A82.56-M76.

.3 Mix - 1 part cement to 3 parts sand, to consistency that can be placed with trowel.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Prepare the slope to be protected by grading smooth to a maximum slope of 2:1 unless shown otherwise on the drawings.

.2 Prepare a trench at the toe of slope if shown on the drawings or ordered by the Engineer.

3.2 FILTER

.1 Place a uniform layer of filter gravel to the thickness shown on the drawings, and to limits shown on the drawings.

.2 Place filter cloth to limits shown on the drawings.

3.3 PLACING ROCK RIP RAP

.1 Class of rip rap shall be as shown on the drawings.

.2 Transport rock to the site, dump and place in a manner that minimizes cracking and spalling, and avoids damage to filter.

.3 Remove material that does not comply with the gradation or specification.

.4 Place rip rap in a manner such that segregation into different sizes does not occur.

.5 Do not use heavy machinery on material in place.

.6 Place rip-rap to a depth equal to or exceeding the largest permitted rock size for the class specified.

.7 Local slope irregularities shall not vary from the design slope by more than 200 mm measured at right angle to the slope.

3.4 PLACING BAGGED CONCRETE RIP RAP

.1 Place bags starting at the bottom row proceeding upward with fastened ends placed in the same direction.

.2 Stagger joints and lightly tamp bags together.

.3 Keep the concrete bags moist for period of 24 hours following placing.

.4 Do not place bagged concrete on frozen ground or when air temperature is at or below 5°C or when there is a possibility of air temperature falling below 5°C within 24 hours of placing.

.5 Do not run equipment on concrete bagged rip rap.

.6 Local slope irregularities shall not vary from the design slope by more than 200 mm measured at right angle to the slope.

3.5 PLACING PRECAST CONCRETE RIP RAP

.1 Place precast concrete in accordance with the manufacturer's recommendations.

.2 Submit shop drawings for precast blocks and anchoring method.

.3 Do not run equipment on precast concrete in place.

.4 Local slope irregularities shall not vary from the design slope by more than 100 mm measured at right angles to the slope.

3.6 PLACING CEMENT MORTAR

.1 Use mortar within 1 hour after water has been added. Do not re-temper.

.2 Commence applying mortar at the bottom courses and above water line and work upwards completely filling voids but leaving outer faces of stones exposed.

.3 Cure and protect mortar in accordance with CAN3-A23.1-M77 using mats or fabric kept continuously wet.

END OF SECTION

Part 1 General

1.1 Related Work Specified in Other Sections

.1 Geotechnical Report

.2 Cast-in-Place Concrete Section 03 30 00

.3 Concrete Reinforcing Section 03 20 00

.4 Earthwork Section 31 00 00

1.2 Reference Standards

.1 All standards to be latest issue at time of tender.

.2 NBC 2010, “Alberta Building Code”.

.3 CAN/CSA-A3000, “Cementitous Materials Conpendium”.

.4 CSA-A23.1-10, “Concrete Materials and Methods of Concrete Construction”.

.5 CSA-A23.2-10, “Methods of Test and Standard Practices for Concrete”.

.6 CSA-A283-00(R2011), “Qualification Code for Concrete Testing Laboratories”.

.7 CAN/CSA-G30.18-09 (R2014), “Billet Steel Bars for Concrete Reinforcement”.

1.3 Regulations

.1 Abide by the current bylaws and regulations of the province and/or municipality in which the work is located, and abide by the current laws and regulations with regard to public safety.

.2 Safety requirements to comply with Construction Manager’s requirement, the regulations of the Minister of Labour, Occupational Health and Safety Act, the Workers’ Compensation Board and other applicable acts administered by the authority having jurisdiction of the province apply to the work of this section.

1.4 Geotechnical Report

.1 Refer to the geotechnical reports and supplements which are included in these specifications and available in the office of the Engineer and Construction Manager.

.2 Ensure the requirements of the geotechnical report and associated supplements are read and understood prior to commencing with work.

1.5 Special Conditions

.1 Ensure that all underground services are located and are not damaged by piling operations. Repair any damage done to existing services at no additional cost to the contract. Services indicated on the drawings are in accordance with available records. The Contractor is responsible for verifying all locations in the field.

.2 The Contractor is to undertake a thorough inspection of existing structures and facilities and document any existing damage. The Contractor will be responsible for repairs of any damage caused by piling operations..

.3 Confirm and establish the locations and extents of all underground structures, services and utilities in the work area prior to commencement of piling work by notifying the applicable owners, authorities or agencies. Clearly mark such locations to prevent disturbance or damage.

.4 Arrange and pay for disconnecting, removing and capping, services and utilities within area of piling work. Disconnect and stub off as required by the authority having jurisdiction.

.5 Place markers to indicate location of disconnected services and utilities. Identify utility and service lines and capping locations on as-built drawings.

1.6 Safety

.1 Carry out cast-in-place concrete work in accordance with the Alberta Building Code and current Occupational Health and Safety Act construction safety regulations.

.2 Carry out piling work in accordance with CSA S350 Code of Practice in Demolition of Structures, Alberta Building Code and current Occupational Health and Safety Act construction safety regulations.

1.7 Qualifications

.1 Engage a professional structural engineer registered in the Province of Alberta, fully qualified and experienced in the design of bored piles, to be responsible for the design of and supervision of installing these piles.

1.8 Design

.1 Pile design has been based on a Factored Ultimate Limit States (ULS) approach. Confirm all soil parameters and design requirements with the geotechnical engineer.

Soil Depth (m)	Factored Ultimate Skin Friction (kPa)	Factored Ultimate End Bearing (kPa)
0 – 1.5m	0	0
1.5m and below	12	240

Geotechnical resistance factor of 0.4 has been applied

.2 End bearing piles (Belled Piles) to be founded minimum 4m below existing ground surface or final grade whichever is lower.

.3 Geotechnical resistance factors may be increased to the values provided in and under the requirements of the NBC 2010.

.4 Piles to be based at the elevation specified or as directed by the Inspection Agency.

.5 See pile schedule for reinforcement and lengths

.6 Pile reinforcing is to extend full length of piles to the bottom of pile.

1.2 Quality Control

.1 Perform concrete work in accordance with the requirements of CSA-A23.1 and Section 03 30 00 unless indicated otherwise herein.

.2 The Piling Contractor must not assign the responsibility of coordination of placing reinforcing steel and placing concrete. To this end, a full time qualified superintendent representing the Contractor is to be in attendance during all phases of the work.

1.3 Inspection and Testing

.1 Piling Contractor is to provide a video camera complete with a monitor suitable for pile base inspection for the duration of the piling contract. Piling Contractor is to video tape the base inspection of the pile as directed by the Inspection Agency and to identify the pile number at the start of each taped recording. The requirements of this clause apply to end-bearing piles only.

.2 Testing of concrete will be carried out by an independent testing firm certified in accordance with CSA A283, retained and paid for by the Owner and approved by the Engineer in accordance with Section 01400 of these specifications.

.3 Test concrete in accordance with CSA-A23.2.

.4 Testing agency is to take at least one slump test and one entrained air test for each set of cylinder taken.

.5 Testing agency to moist cure and test one cylinder in 7 days and the remainder two cylinders in 28 days.

.6 Full time pile inspection of piling operations will be carried out by an independent geotechnical firm, retained and paid for by the Owner and approved by the Engineer. Inspection of the pile bases will be performed by the Inspection Agency for bearing capacity verification. Video camera may be employed where appropriate.

.7 Inspection and testing firm to submit to the Engineer a final report summarizing their inspection and testing and Contractor’s degree of compliance with the contract documents and reviewed shop drawings, including any remedial requirements that may have been required during the course of work. This report is to be submitted under the seal and signature of a professional geotechnical engineer registered in the Province of Alberta.

.8 Notify Engineer and inspection and testing firm five (5) working days in advance of starting piling work on site.

.9 Testing agency shall direct the use of steel casing when site conditions warrant. Keep record of piles that require steel casing and the size and length of the casing used.

.10 Testing agency shall keep record of the pile base elevation of each pile installed. The record is to be used as the basis for calculating the payment to the contractor.

1.4 Submittals

.1 Prior to commencing the work, the Contractor's engineer is to submit documentation showing qualifications and experience. The Contractor's engineer is to further acknowledge in writing that he or she has reviewed the specifications and drawings and is aware that he or she is to inspect the fabrication and installation of work and certify the work at completion.

.2 Submit proof or certificate of source of reinforcement material. Clearly identify recycled content (post-consumer and post-industrial).

.3 Submit in writing evidence of qualifications for welding under C.W.B.

1.5 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 of these specifications.

.2 Clearly indicate the following information:

.1 Pile layout, schedule of installation and placing sequence.

.2 Type of pile, sizes and details.

.3 Grade and details of reinforcing steel.

.4 Type of cement, air content, slump and concrete strength.

.5 Elevation of pile bases.

.6 Elevation of top of pile.

.7 Pile cap sizes and details.

.3 Review of the shop drawings by the Engineer is intended to assist the Contractor and does not relieve the Contractor of responsibility for the completeness and accuracy of the work and its conformance with the contract drawings and specifications.

1.6 Field Records and Drawings

.1 Maintain accurate records of all piles installed. Records are to include the following:

.1 Locations of piles.

.2 Sequence of placing.

.3 Final base and head elevations.

.4 Drilled shaft and bell diameters.

.5 Condition of base material.

.6 Date and time of drilling.

.7 Length of casing.

.8 Reinforcing details.

.9 Date and time of placing concrete.

.10 Details of unusual occurrences.

.11 Inspector's name.

.12 For end-bearing piles only, the Piling Contractor is to provide the video tapes of pile bases inspected by video camera and tapes shall indicate pile reference by the grid location.

.2 Submit three (3) copies of all field records and drawings to the Engineer.

1.7 Lump Sum

.1 In accordance with Bid Form, submit for each type of pile:

.1 A price for each pile installed.

.2 All prices to include costs of drilling, concrete and reinforcing in place as required. Prices shall also include all overheads, profit mark-ups and supervision, etc.

.3 Length of pile is measured from the final pile base elevation to the specified top of pile cut off elevation. Piling Contractor is responsible for all costs associated with installing top of pile to the specified elevation.

Part 2 Products

2.1 Concrete Materials

.1 Conform to the requirements noted under Concrete Materials in Section 03 30 00 of these specifications and as noted herein.

.2 Portland cement: to CAN/CSA-A5 Normal - Type GU as indicated within the specifications section 03 30 00 Casti-in-Place Concrete.

2.2 Reinforcement

.1 Reinforcing steel: To CAN/CSA-G30.18, Grade 400R deformed billet steel bars.

.2 Reinforcing steel: To CAN/CSA-G30.18, Grade 400W special low alloy deformed billet steel for welded bars with equivalent carbon content not exceeding 0.5.

.1 Reinforcing steel material shall consist of minimum 40% post-consumer and 20% post-industrial recycled content.

2.2 Concrete Mixes

.1 Conform to the requirements noted under Concrete Mixes in Section 03 30 00 of these specifications and as noted herein.

.2 Provide concrete mix that is suitable for placement of concrete using tremie under submerged conditions.

2.3 Casing

.1 Conform to ASTM A252, Grade 2, steel casing tube of required diameter for temporary use in wet or soft strata.

.2 Provide steel casing for all piles where required to prevent sloughing and ingress of water.

Part 3 Execution

3.1 Installation

.1 Notify the Engineer and inspection and testing firm 48 hours prior to any installations on site.

.2 Ensure site conditions are adequate to support piling equipment and to allow proper performance of pile operations.

.3 Ensure piling equipment is adequate for soil conditions. Piling Contractor is responsible for maintenance of the site grade and restoring any damages caused by the use of inappropriate equipment.

.4 Do not use piling methods that could cause damage to nearby or existing structures.

.5 Install piles where indicated on drawings. Piling Contractor is responsible for their own survey and layout from designated control point or bench mark.

.6 Ensure pile shafts are drilled vertically and that pile bases are founded minimum depths into bearing material as indicated on the drawings, specified herein, and as indicated in the geotechnical report.

.7 To prevent breakthrough from one pile to another, drill and install piles alternately. Where pile spacing is less than three bell diameters, do not drill the adjacent pile before the previous pile concrete has set or for at least 24 hours.

.8 Use steel casing for all piles to top of bell to prevent sloughing and ingress of water where recommended in the geotechnical report or where required by site conditions. Requirements for casing will be determined and directed by the inspection agency and approved by the Consultant.

.9 Clean pile bases of loose material, and place reinforcing steel and concrete. Perform these operations as soon as possible, but not later than two hours after drilling for each pile. Do not leave any unfilled shafts overnight.

.10 Construct all piles to the top of pile cut off elevation and project vertical reinforcement as specified. Ensure concrete at the pile cut off elevation is sound and satisfactory to the Consultant that no additional preparation or repair work will be required for pile cap construction.

.11 Arrange for and allow inspection of pile shafts and bases before concrete and reinforcing steel are placed.

.1 Provide video surveillance for inspection of pile bases as directed by Inspection Agency.

.2 Provide full length casing and protective cage with hoist and lowering equipment to facilitate downhole inspection and hand cleaning in accordance with the requirements of the Occupational Health and Safety Act.

.3 Place reinforcing steel in accordance with CSA-A23.1, and extend reinforcement into structure above as indicated on the drawings. Use four 64 mm diameter by 450 mm long PVC pipes on the reinforcing steel cage at maximum 3000 mm on centre to ensure proper concrete cover for the reinforcing steel.

.4 Extend reinforcement full length of pile.

.5 Place concrete in vertical piles where the shaft and base are dry by means of a chute minimum 4000 mm in length held rigidly and centred in the pile shaft and the rebar cage. Concrete discharged from the chute is to be prevented from striking the sides of the shaft and the rebar cage.

.6 Vibrate concrete to full depth of reinforcing in the pile.

.7 Remove water from any source by pumping to allow placing concrete in dry conditions.

.8 Place concrete by means of a tremie should an inflow of water occur that can not be removed by pumping. Place to a height sufficient to affect a seal. Notify Engineer prior to carrying out this work. Revise concrete mix design and placing methods as directed by the Engineer.

.9 Protect concrete from freezing. Do not place concrete against frozen ground.

.10 Where casing is used, withdraw casing by vibratory methods to reduce the possibility of concrete arching in the casing. Ensure sufficient head of concrete above the bottom of the casing to resist lateral soil pressures. Ensure pile reinforcement is secure and does not settle due to vibratory methods.

.11 Clean casing thoroughly after each use.

.12 Discontinue piling operations and immediately notify the Geotechnical consultant and Engineer in the event that unusual soil conditions are encountered such that pile load capacities can not be obtained.

.13 Fill abandoned piles with lean mix 2 MPa concrete. Contractor to replace at no additional cost to the contract all piles abandoned due to inadequate equipment or piling operation breakdown.

3.2 Top of Pile Elevation

.1 Make allowance to place concrete to correct top of pile elevations specified on the drawings.

3.3 Tolerances

.1 Do not deviate from true vertical alignment more than 2% of pile length.

.2 Do not deviate from centre of true location more than 50 mm.

.3 Do not deviate from specified head elevations more than 25 mm.

3.4 Non-Conforming Piles

.1 Non-conforming piles are piles that are placed out of position or are damaged and/or piles not conforming to size, length and material specifications.

.2 Provide additional piles or supplement piles with additional pile caps or grade beams to meet specified requirements as directed by the Engineer at no additional cost to the contract.

3.5 Certification

.1 Certify at completion of work all piles installed by the piling contractor under the seal and signature of the Contractor’s professional engineer responsible for this work.

.2 Certify that all piles are capable of developing the capacities specified in the contract specifications and on the drawings.

.3 Certify that all piles are installed in accordance with the contract documents and the reviewed shop drawings.

3.6 Survey Verification

.1 Piling Contractor will survey all pile locations including non-conforming piles. Survey is to be carried out by an independent legal surveyor registered in the Province of Alberta. Piling Contractor is to submit proposed remedial work for non-conforming piles to Consultants for approval prior to proceeding with the work.

3.7 As-Built Drawings

.1 Submit an as-built drawing prepared by an independent legal surveyor registered in the Province of Alberta showing final pile locations, shaft diameter, top of pile elevation of each pile including all deviations and details of unusual occurrences from the original contract document within five (5) days after the completion of all piles.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies the requirements for granular sub-base and base course for roadways and parking areas.

.2 The work includes:

.1 Supply of granular materials.

.2 Placing and compacting sub-base.

.3 Placing and compacting base course.

1.2 RELATED WORK

.1 Grading - Section 31 22 16

.2 Asphaltic plant mix – Section 32 12 16

1.3 MAINTENANCE OF TRAFFIC

.1 Perform work in a manner that will cause the least disruption to traffic.

.2 Closing of streets, detouring of traffic, posting of traffic signs and provision of flagmen shall be the Contractor's responsibility.

.3 Maintain detour roads.

1.4 PERMITS

.1 Obtain all permits required for this section of the work and abide by the stipulations of the permits.

1.5 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 Quality Control.

.2 Submit to the Engineer a list of sources of materials including sand, pit-run gravel, and crushed gravel.

.3 Provide samples, test results, sieve analyses and reports for preliminary approval of materials.

1.6 QUALITY CONTROL TESTING

.1 Refer to Section 01 45 00 - Quality Control.

.2 Moisture density curves to ASTM D698-78.

.3 Sieve analyses to ASTM C136-84a.

.4 Field densities to ASTM D2167-84 or to ASTM D2922-81.

.5 Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number required.

.6 Provide moisture/density curves for each type of material from each source of material to be compacted to a specified density.

.7 Field densities:

.1 Road base - one for each 1200 m^2

PART 2 - PRODUCTS

2.1 GRANULAR SUB-BASE

.1 Consists of sound, hard, durable, uniformly graded pit run or crushed gravel or sand as specified.

2.2 GRANULAR BASE

.1 Consists of sound, hard, durable particles of gravel, stone, sand and fine soil particles crushed to a uniform gradation, and to the maximum size designated.

2.3 GRANULAR SUB-BASE AND GRANULAR BASE

.1 Shall not contain sod, roots, plants or other organic materials, neither shall they contain soft fragments such as shale or flaky particles in excess of fifteen (15%) percent by weight. The materials shall be well graded from course to fine within the gradation limits, and shall not be subject to extreme variation between the lower and upper limits of the gradation band specified.

.2 On the prepared materials that portion of fine aggregate, including supplementary material, if any, which passes the 425 micro-m sieve shall have a Liquid Limit of not more than 25 and a Plasticity Index of not more than 6.

2.4 GRADATION DESIGNATIONS

.1 When tested on Standard Laboratory screens the materials shall meet one or more of the following gradations.

Designation 1 - Sand

Sieve Size	Percent Passing
9.5 mm	100
4.75 mm	90 - 100
150 micro-m	20 max.

Designation 2 - Pit Run Gravel - Max, Size 75 mm

Sieve Size	Percent Passing
75 mm	100
25 mm	60 - 85
4.75 mm	30 - 60
75 micro-m	2 - 10

Designation 3 - Crushed Gravel - Max. Size 20 mm

Sieve Size	Percent Passing
20.0 mm	100
12.5 mm	60-96
5.0 mm	37-76
2.0 mm	26-60
400 mm	11-41
160 micro m	6-21
63 micro m	2-10

For crushed gravel not less than 60 percent of the material retained on the 4.75 mm sieve shall be crushed particles. The ratio of the percentage passing the 75 micro-m sieve shall not exceed two-thirds and preferably not less than one-half.

PART 3 - EXECUTION

3.1 SUB-GRADE

.1 The sub-grade shall be shaped to the cross-section shown on the plans prior to placing the sub-base course thereon. The Contractor shall maintain the sub-grade to the specified compaction and section, free from ruts, waves, and undulations, by whatever means are necessary.

.2 The sub-grade or sub-base course shall be in a firm dry condition before any material is placed thereon and the Engineer's consent must be obtained before placing any granular material.

3.2 PLACING OF SUB-BASE AND BASE COURSE

.1 Unless otherwise specified, the granular material shall be placed in uniform layers not exceeding 150 mm in thickness before compaction. The material shall be placed by mechanical spreaders or deposited in windrows and levelled with a suitable motor grader.

3.3 COMPACTION OF SUB-BASE AND BASE COURSE

.1 The granular sub-base and base course material shall be compacted by rolling with a pneumatic tired roller, vibratory roller or other approved type. Each layer shall be compacted at the optimum moisture content, to 100 percent of the maximum dry density as determined by the Standard Proctor Compaction Test for the material used.

.2 During compaction, water shall be added by an applicator, in such quantities that the moisture content will be maintained at the optimum level as determined by the Standard Proctor test. If the moisture content exceeds the optimum moisture content, the material shall be aerated by mechanical means or work shall cease temporarily until the material has dried sufficiently to reach the optimum moisture content.

3.4 SHAPING OF SUB-BASE AND BASE COURSE

.1 A blade grader shall be used in conjunction with the compaction equipment to keep the finished surface of each layer even and uniform. The finished surfaces of the granular base course and sub-base course shall conform to the required cross-section and grades as shown on the drawings and as staked by the Engineer, within a tolerance of plus or minus 15 mm. The finished sub-base course surface shall show no depression more than 13 mm under a straight edge of 3 m long placed parallel to the road centre line. The finished base course surface shall show no depression more than 6 mm under a straight edge 3 m long placed parallel to the road centre line.

3.5 PROOF ROLLING

.1 If ordered by the Engineer, the Contractor shall supply and operate a loaded test vehicle of 8 200 kg axle load to test the sub-base and base for rutting and weaving.

.2 Where proof rolling indicates areas that are defective, remove and replace according to this specification at the Contractor's expense.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for asphaltic plant mix base course and surface course.

.2 The work includes supply of aggregates, and asphalt; preparation and placing and the supply and placing of prime and tack coats.

1.2 RELATED WORK

.1 Grading and sub-grade preparation **-** Section 31 22 16

.2 Granular Base Course – Section 32 11 00.

1.3 MAINTENANCE OF TRAFFIC

.1 Perform work in a manner that will cause the least disruption to traffic.

.2 Closing of streets, detouring of traffic, posting of traffic signs and provision of flagmen shall be the Contractor's responsibility.

.3 Maintain detour roads.

1.4 PERMITS

.1 Obtain all permits required for this section of the work and abide by the stipulations of the permits.

.2 Notify the Engineer as to intended sources of supply of aggregates.

1.5 QUALITY ASSURANCE

.1 The Contractor is totally responsible for the quality of materials and products which he provides for the Work.

.2 Materials supplied by the Contractor shall be tested for compliance with the specifications by the Contractor.

.3 Refer to Section 01 45 00 – Quality Control.

.4 The Contractor shall submit copies of test data to the Engineer within 24 hours of receiving results.

1.6 MINIMUM QUALITY CONTROL TEST FREQUENCIES

.1 The following frequencies of testing are the minimum required. The Contractor shall perform as many tests as are necessary to ensure that the work conforms to the requirements of the Contract regardless of the minimum number specified.

.2 Submit a certified laboratory analysis to the Engineer for each shipment of asphalt cement.

.3 Provide test data re the temperature viscosity relationship.

.4 Submit one copy of results of each of the following control tests for each class of aggregate to be used:

- .1 Los Angeles Abrasion Test - ASTM C131-81
- .2 Crushed Fragments
- .3 Specified Gravity and Absorption ASTM C127-84 and ASTM C128-84
- .4 Material passing 75 micro-m sieve - ASTM C117-87

.4 Combined aggregate tests shall be taken prior to the aggregate being combined with asphalt.

- .1 Sieve analysis (ASTM C136-84A) will be taken daily.
- .2 Moisture contents of dried aggregates will be taken daily.

.5 The testing agency shall sample asphalt mixtures daily, and in accordance with ASTM D1559-82 method subject the samples to a density and air voids analysis and an asphalt content determination.

.6 A stability value shall be established at least once in each five days of mixing.

.7 Density determination and air void contents shall be taken by the Testing Agency at a rate of one test for each 1,600 m^2 of each layer; and at least one each day during placing operations.

.8 Nuclear density determinations, if required by the Engineer, will be in accordance with ASTM D2950-71 and will be at a rate of 5 tests per 1,600 m^2 of each layer.

.9 Final curing and analysis tests will be taken at the rate of one test each 4,000 m^2 of pavement.

.10 Cores will be measured and tested to provide the following information.

.1 Thickness

.2 Asphalt content

.3 Density

.4 Sieve analysis

.5 Percentage voids (ASTM D3203-83)

1.7 QUALITY CONTROL TESTING BY THE OWNER

.1 The Owner may employ a testing agency to do on-site materials testing in addition to the Contractor's Quality Control Testing as the work progresses.

.2 The Engineer and the Owner's testing agency shall have access at all times to all parts of the operation for testing, for verification of weights, temperatures, proportion and character of materials.

.3 The Contractor shall provide the means at the asphalt mixing plant for the Owner's testing agency to obtain representative samples for testing of combined aggregates.

1.8 SUBMITTALS - MIX DESIGN

.1 The Contractor shall pay for and submit duplicate copies of a design mix as recommended by a testing agency employed by the Contractor.

.2 The Contractor shall submit to the Engineer a mix design for each required asphalt concrete mix type at least 10 days before start of production and for each subsequent change in supplier or source of materials. No hot-mix production can proceed until the applicable mix design and job-mix formula are approved by the Engineer.

.3 Mix types: Mixes are designed according to use as follows:

.1 <u>Surface</u> (ACS) (Mix B) - surface course for freeways, arterials, industrial/ commercial and collectors.

.2 <u>Base</u> (ACB) (Mix A) - base course for freeways, arterials, industrial/ commercial and collectors.

.3 <u>Residential</u> (ACR) - for paving residential streets only.

.4 <u>Residential</u> (Type III) - for paving residential streets only - base course

.4 The mix design shall be performed by a qualified laboratory possessing a permit to practice under the Engineering, Geological and Geophysical Professions Act of Alberta, following the Marshall Method of Mix Design as set out in the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2) to the following criteria:

MIX TYPE	ACS	ACB	ACR	TYPE III
Max size of aggregate, mm	20	25	12.5	20
No. of blows	75	75	50	75
Minimum stability, kN	6.7	6.7	4.5	6.5
Min retained stability, %	75	75	75	75
Flow value, 0.254 mm unit	6-12	6-12	8-16	6-12
Air voids, % of total mix	4.0 ± 0.2	4.0 ± 0.4	3.0 ± 1.0	3.0 ± 1.0
Voids filled, %	70-75	70-75	75-85	70-75
Minimum film thickness, mm	6.5	6.0	7.0	6.0

1.9 JOB MIX FORMULA

.1 Submit with the mix design the proportions of materials and plant settings to include the following:

.1 For Batch Plant:

.1 Sieve analysis of the combined aggregate in the mix.

.2 Sieve analysis of aggregate in each bin separation to be used.

.3 Mass of material from each bin for each batch of mix.

.4 Mass of asphalt in each batch.

.5 Mixing temperature of the asphalt as determined from its temperature viscosity relationship.

.2 For Continuous or Drum-Mix Plant:

.1 Sieve analysis of combined aggregate in the mix.

.2 Mass of asphalt by tonne of mix.

.3 Mixing temperature of asphalt determined from its temperature-viscosity curve.

.4 Settings of aggregate and asphalt feed systems.

.3 The quality assurance laboratory will test a trial batch of job-mix formula to verify the mix design. The mix design and job-mix formula will not be approved until successful results are obtained. If the initial trial batch fails, submit results of further trial batch tests performed by a quality control laboratory.

.4 Do not make changes to approved job-mix formula without written approval from the Engineer.

.5 Display approved job-mix formula in clear sight of plant operator. Failure to display the currently approved job-mix formula will result in a plant shutdown order by the Engineer.

.6 Production rate: Produce hot-mix at a rate compatible with the rate of placement and compaction of the job.

.7 Recommended quality control plan: Before commencing hot-mix production, submit for the Engineer's review a quality control plan including the following recommended tests and frequency for each mix type produced. Make test results available weekly to the Engineer for review.

.1 Tests: Three Marshall specimens per test

- Asphalt content
- Air voids
- Stability and flow
- Film thickness
- Moisture content in mix
- Gradation in mix
- Plant discharge temperature
- Asphalt storage temperature

.2 Frequency: a minimum of two tests per day in full production

.8 Tolerances and Quality Assurance:

.1 Mixing Temperature Tolerance: Allowable variation from design mixing temperature shall be ± 9° C.

.2 Asphalt Cement: Samples of asphalt cement used will be taken weekly from each source and tested for penetration and kinematic viscosity.

.3 Production Mix Analysis: Samples will be taken for each 1000 t minimum of hot-mix, or each day's production, whichever is less, and subjected to complete Marshall testing.

.1 Asphalt Content Tolerance: Allowable variation from approved design asphalt content shall be ± 0.3% by mass of mix.

.2 Tolerance in Extracted Aggregate from Approved Job-Mix Gradation:

% Passing by Mass

Sieve Size (mm)	Individual Sample	Average of Last 10 Samples
5.0	± 5.0	± 3.0
1.25	± 4.0	± 2.5
.63	± 3.0	± 2.0
.315	± 3.0	± 2.0
.15	± 2.0	± 1.5
.80	± 1.5	± 1.0

.4 Crushed-Face Count: For each mix type, the minimum percentage, by mass retained down to the 5 mm sieve, having at least two crushed-faces shall be as follows, provided there is a minimum 50% crushed-face counts in each individual sieve size greater than 5 mm:

Mix Type:	ACS	ACB	ACR	Type III
Crushed-Face Count	75%	70%	70%	60%

.5 Tolerance for Air Voids in Mix:

Mix Type:	ACS	ACB	ACR	Type III
Air Voids, %	4.0 ± 1.0	4.0 ± 1.0	3.0 ± 1.0	3.0 ± 1.0

.9 Nonconforming Mix Production: If one or more of the preceding mix production tolerances are exceeded, the Engineer will order suspension of mix production until the Contractor has demonstrated to the Engineer's satisfaction that corrective measures have been taken to produce a mix that meets requirements.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING

.1 Handle all aggregate in a manner that will prevent segregation, and intrusion of foreign materials.

1.11 SITE EXAMINATION

.1 Examine all existing structures and protect them from damage during laying operations.

.2 Ascertain that the base course is properly compacted and prepared for placement of the surface course.

PART 2 - PRODUCTS

2.1 PRIME COAT

.1 Bituminous primer MC-0 or MC-1 (MC-30 or MC-70) or as approved by the Engineer.

2.2 ASPHALT CEMENT

.1 Asphalt shall be prepared by the refining of petroleum.

.2 Asphalt shall be uniform in character and shall not foam when heated to 177°C.

.3 Delivery temperature shall be between 135°C and 177°C.

.4 One of the following grades will be selected by the Engineer, on the basis of the laboratory analysis results.

	ASTM	Grades	
Characteristics	Test	AC5	AC2.5
	Method	Min.	Min.
Viscosity at 60°C,			
in poises	D2171-85	500	250
Penetration at 25°C,			
100 gm., 5 sec.	D5-86	150	250
Thin Film Oven Test,	D1754-83		
Penetration after test			
25°C, 100 gm., 5 sec.			
% of original	D5-86	45	45

2.3 TACK COAT

.1 R.C. 30 asphalt or as approved by the Engineer.

2.4 SAND

.1 100% passing 4.75 mm sieve - clean granular sand.

2.5 MINERAL AGGREGATE

.1 Coarse fractions shall consist of hard, clean, durable crushed stone, crushed slag, crushed gravel or a combination thereof or of material naturally occurring in a fractured condition.

.2 Coarse aggregates shall meet the quality requirements of ASTM D692-85.

.3 Fine aggregates shall consist of natural sand and/or manufactured material derived from crushing stone, slag or gravel. All particles shall be clean, tough, durable, moderately sharp and free from coatings of clay silt or other deleterious materials and shall contain no organic matter.

.4 When tested by means of laboratory sieves, the combined aggregates in the mix shall meet the following requirements for the various mix types:

Mix Type:	ACS	ACB	ACR	Type III
Designation 1 Class	20	25	12.5	20
Sieve Size (mm):	Total Passing Sieve Percent by Mass			
25	--	100	--	--
20	100	80-95		100
12.5	80-95	--	100	--
5	45-65	40-60	60-80	40-65
0.8	--	--	--	20-36
.16	9-14	9-14	9-14	--
.08	4-8	4-8	4-8	--
.063	--	--	--	2-10

.1 Coarse Aggregate is that fraction of the total aggregate retained on the 5 mm sieve.

.2 Fine Aggregate is that fraction of the total aggregate passing the 5 mm sieve.

.1 Fine aggregate shall contain manufactured or crushed fines at a percentage by mass of fine aggregate as follows:

Mix Type:		Surface	Base
Manufactured Fines:	Minimum	70%	60%
	Maximum	85%	

.2 Pit-run material shall be pre-screened to remove natural sand and subsequently crushed and screened to obtain manufactured fines.

.3 Aggregate in Stockpile:

.4 Stockpile aggregate in horizontal lifts. Stacking conveyors are not allowed for stockpiling. Draw aggregate from stockpile in a manner that mixes the full depth of stockpile face.

.5 When it is necessary to blend aggregates from one or more sources to produce the combined gradation, stockpile each source or size of aggregate individually. Do not blend aggregates in stockpile; feed through separate bins to the cold elevator feeders.

.5 Aggregate Quality Control:

.1 Engage a quality control laboratory to conduct aggregate sampling, sieve analysis to ASTM C136, crushed face count, abrasion and soundness tests. Submit abrasion and soundness test results for each aggregate source. Submit results of sieve analysis and crushed face count to the following frequencies:

.1 For Existing Stockpile at Time of Contract Award: a minimum of one sieve test and one crushed face count per 1000 t. Submit also the average gradation of entire stockpile when submitting a mix design using it.

.2 For Aggregate Stockpiled During Contract: a minimum of one sieve test and one crushed face count per 1500 t, or each day's production, whichever is less. Submit results within 24 hr of testing.

.2 Do not use aggregate until test results have been reviewed and accepted by the Engineer.

.3 Notify the Engineer when production of the manufactured fines is scheduled, so that he has the opportunity to inspect the manufacturing process. Failure to notify the Engineer will result in non-approval of the fines for use in asphalt concrete.

2.6 MINERAL FILLER

.1 Portland cement, fly ash or ground limestone may be used if necessary to meet grading specifications and if permitted by the Engineer. Submit mill tests and gradation prior to hot-mix production and as requested by the Engineer. Mineral filler shall have zero plasticity index and shall meet the following gradation:

Sieve Size (mm)	% Passing, by Mass
.40	100
.16	90 minimum
.08	70 minimum
.045	62 minimum

PART 3 - EXECUTION

3.1 INSPECTION

.1 No priming or paving shall be carried out until the surfaces to be paved have been inspected and approved by the Engineer.

.2 If ordered by the Engineer the Contractor shall supply and operate a loaded test vehicle of 8 200 kg axle load to test the subbase and base for excessive rutting.

.3 The load test will be directed by the Engineer and the Contractor shall pay for the test vehicle and for any repairs required to the road base.

.4 Remove ruts, waves and undulations by mechanical means.

.5 Clean and check the base course to ensure that the surface of the base course is within 6 mm of the design grade.

3.2 GENERAL

.1 Construction traffic on pavements under construction shall be suitable in relation to the thickness of the courses it traverses so that damage is not caused to the sub-grade or material already compacted.

.2 The wheels or tracks of equipment moving over the various pavement courses shall be kept free from deleterious materials.

.3 Base course shall be kept clean and uncontaminated for so long as it remains uncovered by a wearing course or surface treatment. The only traffic permitted access to base course material shall be that engaged in laying and compacting the wearing or surface course or, where the base course is to be blinded or surface dressed that engaged on such a surface treatment. Should the base course become contaminated, the Contractor shall make good by cleaning it to the satisfaction of the Engineer and if this proves impracticable, by removing the layer and replacing it to specification.

.4 Any piece of machinery causing the spillage of fuel oil, lubricating oil or hydraulic oil onto the surface prior to laying or onto the finished surface shall be removed from the work. Any areas of base or surface course affected by the spillage will be cut out and replaced as the Engineer shall direct and at the Contractors own expense.

.5 Any final surface found to be defective either in finished quality or as a result of subsequent laboratory testing, will be cut out and replaced at the Contractors expense. The area cut out of any final pavement surface will be not less than 15 m longitudinally by the full width of the section laid down.

.6 If it is necessary to use aggregates from more than one source, the material shall be introduced into the dryer through a divided system of cold feed. The material shall be fed in such a manner that no segregation to the various sources takes place.

.7 The net weight of asphaltic binder added to the mix shall be controlled to within 2 percent of the specified weight in kg required. Plants using the fluidometer method must be equipped with a bypass and scale in order that the actual weight of the bitumen used in kg may be quickly checked.

3.3 APPLICATION OF PRIME COAT

.1 All surfaces including the surface of the base and edges of existing buildings or curbs and gutters shall be completely dry and free of loose material before the prime coat is applied. No primer shall be applied when the ambient temperature is lower than 10°C. No priming shall be carried out until the surfaces to be primed have been inspected and approved by the Engineer.

.2 Application shall be made uniformly by means of an approved pressure distributor at a rate of 1.08 to 2.17 Litres per m^2 at an application temperature of 21° to 50°C or as directed by the Engineer. Sufficient primer shall be applied to completely cover the surface and to be absorbed and set within a period of 24 hours.

.3 Blot up excess primer with sand and keep traffic off the primed area until the primer has been absorbed.

.4 Priming includes priming the edges of existing curbs, gutters and pavement.

3.4 EQUIPMENT

.1 Plant - General

.1 Use a batch mixing type plant or other type approved by the Engineer which is capable of combining, drying and heating the mineral aggregate, heating the asphalt and accurately proportioning all materials to produce an asphaltic hot mix possessing the foregoing characteristics within designated tolerances. It shall be complete with a drier equipped with a dust collector, a gradation control unit to reject over-size material and to separate and store the dried aggregate into at least three hot material bins, a positive displacement asphalt pump, a twin shaft pugmill, a weight box or hopper equipped for accurately weighing the aggregates, and proper thermometric equipment.

.2 The Engineer or his authorized representative shall have access at any time to all parts of the paving plant.

.3 The plant used shall be of a type which is approved by the Engineer and which shall be so designed, coordinated and operated to provide a mixture conforming to the job mix requirements.

.2 Equipment for Preparation of Bituminous Materials

.1 Tanks for storage of bituminous materials shall be equipped for heating the material, under effective and positive control at all times, to the temperature required in the paving mixture specifications. Heating shall be done by steam or oil coils, electricity, or other means such that no flame shall contact the heating tank.

.2 A circulation system for the bituminous material shall be of adequate capacity to provide proper and continuous circulation between storage tank and proportioning units during the entire operating period.

.3 All pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss.

.4 The discharge end of the bituminous binder circulating pipe shall be kept below the surface of the bituminous material in the storage tank to prevent discharging the hot bituminous material into the open air.

.5 Storage tank capacity shall suffice for at least one day's run.

.6 The Contractor shall provide a sampling outlet in the bituminous material feed lines connecting the plant storage tanks to the bituminous material weighing system. The outlet shall consist of a valve installed in such a manner that samples may be withdrawn from the line slowly at any time during the plant operation. The sampling outlet shall be installed between the pump and the return line discharge in a location that is readily accessible and free from obstruction. A drainage receptacle shall be provided for flushing the outlet prior to sampling.

.3 Feeder for Dryer

.1 The plant shall be provided with mechanical means for uniformly feeding the aggregate into the dryer so that uniform production and temperature may be assured. When aggregates must be blended from two or more sources at the cold feed to meet the requirements of the job mix formula a synchronized proportioning method shall be provided.

.4 Dryer

.1 A dryer of satisfactory design shall be provided. The dryer shall be capable of drying and heating the aggregate to the moisture and temperature requirements set forth in the paving mixture specifications, without leaving any visible unburned oil or carbon residue on the aggregate discharged from the dryer.

.5 Screens

.1 Plant screens shall have adequate capacity and size range to properly separate all of the aggregate into the sizes required for proportioning so that they may be recombined consistently within the specification limits.

.2 6 mm and 3 mm screens shall be provided in the plant to ensure proper control of the uniformity of mix.

.3 Over-run shall be limited to having not more than twenty (20) percent in any one bin.

.4 Screens shall be checked daily and cleaned when necessary.

.6 Bins

.1 The Plant shall have a hot bin storage of sufficient capacity to ensure uniform and continuous operation. Bins shall be divided into the specified number of compartments arranged to ensure separate and adequate storage of appropriate fractions of the aggregate.

.2 Each compartment shall be provided with an overflow pipe of such size and at such location to prevent any backing up of material into other bins or into contact with the screen.

.3 Adequate additional dry storage shall be provided for mineral filler, when required, and provisions shall be made for accurate proportioning.

.4 Bins shall be equipped with "telltale" devices to indicate the position of the aggregate in the bins at the lower quarter points. An automatic plant shut off shall be provided to operate when any aggregates bin becomes empty.

.5 Adequate and convenient facilities shall be provided for obtaining aggregate samples from each bin.

.7 Weight Box or Hopper

.1 The equipment shall include a means for accurately weighing each bin size of aggregates into a weight box or hopper, suspended on scales and ample in size to hold a full batch without running over.

.2 The weight box or hopper shall be supported on fulcrums and knife edges that will not easily be thrown out of alignment or adjustment.

.3 Gates, both on the bins and the hopper shall be constructed to prevent leakage when closed.

.8 Aggregate Scales

.1 Scales for any weigh box or hopper may be of either beam or springless dial type and shall be of standard make and design having tolerances on over registration not exceeding 0.1 percent of the indicated weight when tested for accuracy.

.2 All weighing equipment shall be tested and sealed as often as the Engineer may deem necessary to ensure accuracy.

.9 Bituminous Control Unit

.1 Satisfactory means, either by weighing or metering, shall be provided to obtain the proper amount of bituminous material. Metering devices shall prove accurate to within 2 percent variation, above or below the actual weight in kg required.

.2 Adding the bituminous material shall not take more than 10 seconds. Where the quantity of bitumen is metered, provision shall be made to check the delivery of the meter by actual weight.

.3 Suitable means shall be provided either by steam or oil jacketing or other insulation for maintaining specific temperatures of the bitumen in the pipe lines, meters, weigh buckets, spray bars, and other containers or flow lines.

.10 Thermometric Equipment

.1 An armored recording thermometer of suitable range shall be fixed in the bituminous material feed line at a suitable location near the discharge at the mixer unit.

.2 The plant shall be equipped with approved automatic recording thermometers, pryometers, or other approved recording thermometric instruments at the discharge chute of the dryer and in the hot fines bin to register and record automatically the temperatures of the heated aggregate.

.11 Mixer Unit for Batch Method

.1 The plant shall include a batch mixer of an approved twin pugmill type capable of producing a uniform mixture within the permissible job mix tolerances.

.2 It shall have a batch capacity of not less than 0.9 t.

.3 The mixer shall be designed to provide means of adjusting the clearance between the mixer blades and liner plates to ensure proper and efficient mixing.

.4 The mixer shall be of the enclosed type.

.5 The mixer shall be constructed to prevent leakage of the contents.

.6 Mixer discharge shall not cause appreciable segregation.

.7 The mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until closing of the mixer gates at the completion of the cycle; it shall lock the bituminous material control unit throughout the dry and wet mixing period.

.8 The dry mixing period is defined as the interval of time between the opening of the weigh box gate and the application of the bitumen. The wet mixing period is the interval of time between the start of application of the bituminous material and opening of the mixer gate.

.9 The timing control shall be flexible and capable of being set at intervals of not more than 5 seconds throughout cycles up to 3 minutes.

.12 Dust Collectors

.1 When plants are located where dust may be objectionable or where dust interferes with the efficient operation of the plant, proper housing, mixer covers, or duct collective systems shall be installed. Provisions shall be made to waste the material collected or to return it uniformly to the mixture as the Engineer may direct.

.13 Safety Requirements

.1 Adequate and safe stairways to mixer platforms shall be provided and guarded ladders to other plant units shall be located where required.

.2 All gears, pulleys, chain, sprockets and other dangerous moving parts shall be thoroughly protected.

.3 Ample unobstructed space shall be provided on the mixing platform.

.4 An unobstructed passage shall be maintained at all times in and around the truck loading space. This space shall be kept free of drippings from the mixing platform. A ladder or platform shall be located at the truck loading space to permit easy and safe inspection of the mixture as it is delivered into the trucks. Overhead protection shall be provided where required.

.14 Continuous Mixing Plants

.1 Continuous plants will not be accepted unless prior approval is received from the Engineer.

.2 Approval will depend on uniformity of source of aggregates, type of plant and location.

.3 In addition to the above, continuous plants must meet the requirements as laid down by the Asphalt Institute, with regard to Special Requirement for Continuous Plants.

3.5 PREPARATION OF HOT MIX MATERIAL

.1 Preparation of Mineral Aggregate

.1 The mineral aggregates shall be dried to maximum moisture content of 1/2 of 1 percent, and heated so that when delivered to the mixing unit, they shall be at as low a temperature as is consistent with proper mixing and laying and in no case to exceed 163°C. The mineral aggregate may be fed simultaneously into the same dryer, but in all cases immediately after heating, they shall be screened into bins, with separation on the 6 mm, 3 mm, and such other coarser sieves specified as the number of bins permit.

.2 Preparation of Binder

.1 The asphaltic binder shall be carefully heated to a specified temperature between 118°C and 150°C depending on the temperature viscosity relationship, by approved means designed to secure uniform heating of the entire contents of the storage tank. The temperature differential between aggregates and binder shall at no time be more than 4°C.

.3 Composition of Mixture

.1 The mineral aggregate and asphaltic binder shall be mixed in a manner to produce a homogeneous mixture in which all particles of the mineral aggregate are uniformly coated and in such proportions as to produce a mixture having an asphaltic binder content as indicated by the approved job mix formula. When the mixture is prepared in a twin pugmixer, the volume of mineral aggregate and asphalt cement shall not be so great as to extend above the tips of the mixer blades when those blades are in a vertical position.

.2 After the hot aggregate and mineral filler have been charged into the mixer, and thoroughly mixed for a period of not less than 15 seconds, as directed by the Engineer, the asphaltic binder shall be added and the mixing continued for a period of at least 20 seconds, and not more than 45 seconds.

3.6 HAULING OF ASPHALTIC PLANT MIX MATERIAL

.1 Truck boxes must be clean and lightly lubricated with thin oil, and loads shall be covered when, in the opinion of the Engineer, weather conditions require it.

.2 Trucks must be driven in a manner such that damage will not occur to surfaces and slopes of the roadway.

.3 Deliver hot mix material at a temperature within 10°C of the temperature specified by the Engineer.

.4 Do not haul over previously placed asphalt until it is compacted and cooled.

3.7 PREPARATION OF BASE

.1 Clean the prepared base free of loose or foreign material.

.2 Where old asphalt surfaces are to be overlaid, apply an approved emulsion or cut back asphalt to the surface at the rate of 0.50 to 1.50 L/m^2.

.3 Base surfaces shall be dry when hot mix asphalt is placed.

3.8 SPREADING THE MIXTURE

.1 General

.1 Hot mix asphalt shall be placed with time remaining so that compaction can be completed during daylight hours, when the air temperature is 2°C, and rising and the road surface is dry.

.2 The mixture shall not be placed when in the opinion of the Engineer, the road and weather conditions are unfavorable.

.3 The mixtures shall be laid when temperatures, as measured in the truck boxes are not lower than 124°C, or more than 150°C. Trucks shall have an accessible 6 mm diameter hole, drilled into the driver's side of the box at a distance of 0.3 m from the box bottom for purposes of checking asphalt mixture temperatures.

.2 Mechanical Spreading

.1 Spread the mixture by means of a mechanical self-powered paver, capable of spreading the mix, within the specified tolerances, true to line, grade and crown set by the Engineer. The paving machine shall be operated so that material does not accumulate and remain along the sides of the receiving hopper. Pavers shall be equipped with a quick and efficient steering device and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws which place the mix evenly in front of adjustable screed.

.2 The screed shall include strike-off devices operated by cutting, crowding or other action which is effective on mixes at workable temperatures without tearing, shoving or gouging them, and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required. The screed shall strike off the mix to the depth and cross-section specified.

.3 Pavers shall operate when laying mixtures at such a speed between 2.4 m and 6.0 m per minute, or as may be decided by the Engineer.

.4 Equipment which leaves tracks or indented areas which cannot be corrected in normal operations, or which produces flushing or other permanent blemishes or fails to produce a satisfactory surface, shall not be used.

.5 Pavers shall be capable of spreading mixes without segregation or tearing. They shall also be capable of placing courses in thickness from 13 mm to at least 150 mm. Extensions and cut off shoes shall permit changes in widths by increments of 150 mm or smaller. They shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips of courses of the same thickness.

.6 Each paving machine shall carry an approved 3 m straight-edge for checking finished surfaces.

.7 Transverse joints in succeeding courses shall be offset at least 1.2 m.

.8 Immediately after any course is screeded and before roller compaction is started, the surface shall be checked, any inequalities adjusted, all accumulation from the screed removed by rake or hoe, and all fat spots in any course removed and replaced with satisfactory material.

.9 Irregularities in alignment and grade shall be corrected before rolling. Before the addition of material to any mat, the surface must be broken with the tynes of a rake to ensure proper blending.

.10 Edges against which additional pavement is to be placed shall be straight and approximately vertical. A lute or rake shall be used immediately behind the paver, when required to obtain a true line and vertical face.

.11 The Contractor shall provide a competent workman who is capable of performing the work incidental to the correction of all pavement irregularities. Special attention shall be given by him to the straight edging of each course following the initial rolling.

.3 Hand Spreading

.1 In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Engineer.

.2 Placing by hand shall be performed carefully; the material shall be distributed uniformly to avoid segregation of the coarse and fine aggregates. Broadcasting of material shall not be permitted during the spreading operations, but all material shall be thoroughly loosened and uniformly distributed by lutes or rakes. Material that has formed into lumps and does not break down readily shall be rejected.

.3 Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

.4 Heating equipment used for keeping hand tools free from asphalt shall be provided. Caution shall be exercised to prevent high heating temperatures which may burn the material. The temperature of the tools when used shall not be greater than the temperature of the mix being placed. Heat only will be employed to clean hand tools; petroleum oil or solvents will not be permitted.

3.9 COMPACTION

.1 Breakdown Rolling

.1 The breakdown roller shall be an approved type of pneumatic tired roller whose tire pressures can be varied while the vehicle is moving.

.2 The Contractor shall furnish to the Engineer charts and tabulations showing the contact areas and contact pressures for the full range of the inflation pressures and for the full range of tire loadings to each type and size compactor tire furnished.

.3 The rollers shall be equipped with pneumatic tires of equal size and diameter which are capable of exerting average contact pressures varying from 275 kPa to 690 kPa by adjusting tire inflation pressure while in motion. The wheels of the roller shall be so spaced that one pass will accomplish one complete coverage equal to the rolling width of the machine. There shall be a minimum of 6 mm overlap of the tracking wheels. The wheels shall oscillate but not wobble. The roller shall be so constructed that the contact pressure shall be uniform for all wheels.

.4 Steel wheeled rollers shall immediately follow the pneumatic tired breakdown roller. Steel wheeled rollers may be of three types; three wheeled rollers, two axle tandem rollers and three axle tandem rollers. These rollers shall be equipped with power units of not less than four cylinders and working under conditions shall develop contact pressures under the compression rolls of 113 to 159 Kg per 25 mm of width.

.5 Rollers shall be equipped with a reversing clutch adjustable scraper to keep the wheel surfaces clean and with means of keeping them moist to prevent mixes from sticking. These surfaces shall have no flat areas, openings or projections which will mar the surface of the pavement.

.6 The three axle tandem rollers shall be so constructed that, when locked in position for all treads to be in one plane, the roller wheels are held with such rigidity that, if either front or centre wheel is unsupported, the other two wheels will not vary from the plane more than 6 mm.

.7 The use of vibratory packers will be permitted in conjunction with rubber tired packers. They shall be of a type designed for rolling asphalt which allows adjustment to the frequency of vibration. The resonant frequency for the equipment and material shall be determined by the Contractor and approved by the Engineer.

.2 Rolling

.1 The rollers shall move at a slow but uniform speed with the drive roll or wheel nearest the paver. The speed shall not exceed 4.8 km/h for steel wheeled rollers or 8 km/h for pneumatic tired rollers.

.2 The line of rolling shall not be changed suddenly or direction of rolling reversed suddenly. If rolling causes displacement of material, the affected areas shall be loosened at once with lutes, rakes or shovels and restored to the original grade of the loose material before being rerolled. Heavy equipment or rollers shall not be permitted to stand on the finished surface before it has been compacted and thoroughly cooled.

.3 During rolling, the roller wheel shall be kept moist with only sufficient water to avoid picking up the material.

.3 Joints

.1 The mixture shall be laid so that all longitudinal joints are made while the first mat is still hot.

.2 A narrow strip along the edge of a mat which is to be joined with another asphalt mat shall be left without rolling until the adjoining mat has been placed against it. The joint which is formed shall be rolled immediately after the adjacent mat has been placed to ensure a bonding of the material while the asphalt is still hot.

.3 Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints must be straight edged or string lined to ensure smoothness and true alignment.

.4 Where previously laid asphalt or existing asphalt is encountered it shall be cut back, at the Contractor's expense, to a point where approximately 50 mm of asphalt is exposed. When spreading is resumed, the exposed edge of the joint will be painted with an approved bituminous material and the freshly laid mixture raked against the joint, tamped with hot tampers and rolled.

.4 Existing Structures

.1 All concrete or metal structures such as curbs and manholes, shall be painted with a thin coat of approved bituminous material on the surface that will be covered by plant mix material.

.2 Where mechanical placing methods will not produce the proper bond at joints, gutters, curbs or other structures, hand methods will be required for placing, spreading, raking and tamping the mix, in order that satisfactory results may be obtained.

3.10 DENSITY

.1 Required Density: Each mat of hot-mix placed shall be compacted to the following minimum density (% of Marshall density) for the type of paving, or as indicated in the Supplementary Conditions or drawings.

Minimum Density	Type of Paving
98%	New and staged paving of road base and surface
96%	Second stage residential mat 40 mm thick or less
97%	Lane paving
97%	Overlay more than 40 mm thick
96%	Overlay 40 mm thick or less.

.2 Sampling and Testing: The quality assurance laboratory will:

.1 Determine the density of laboratory compacted Marshall specimens at a minimum frequency of one Marshall density for every 1000 tonnes of hot-mix, or a day's production, whichever is less.

.2 Drill cores from compacted mat placed from same load of hot-mix from which Marshall specimens were taken, or from suspect compacted mat, and test for density.

.3 Basis of Acceptance: Pavement compaction will be accepted on the basis of the ratio (in percent) of the core density to the density of Marshall specimen. If cores were drilled from mat where no Marshall specimen was taken, acceptance will be based on ratio of core density to the average density of all Marshall specimens to date.

.4 Representative Cores: A single core is initially taken representing quantity of hot-mix in not more than 1000 m^2 of mat, with a minimum of one core taken from a day's production. If the core density is below specified, three more cores will be taken from the same area and the average density of the three new cores represents that area.

.5 Deficient Density: If the average core density is below specified, the represented area of mat may be accepted subject to a pay factor according to the following table to be applied to the price of the quantity of hot-mix in that mat area.

ASPHALT DENSITY PAY FACTORS

98% REQUIRED		97% REQUIRED		96% REQUIRED	
Actual Density	Pay Factor	Actual Density	Pay Factor	Actual Density	Pay Factor
%		%		%	
98.0	100.0	97.0	100.0	96.0	100.0
97.9	99.9	96.9	99.9	95.9	99.7
97.8	99.8	96.8	99.7	95.8	99.3
97.7	99.6	96.7	99.4	95.7	98.9
97.6	99.4	96.6	99.1	95.6	98.4
97.5	99.1	96.5	98.7	95.5	97.8
97.4	98.7	96.4	98.2	95.4	97.1
97.3	98.3	96.3	97.7	95.3	96.4
97.2	97.8	96.2	97.1	95.2	95.6
97.1	97.2	96.1	96.3	95.1	94.6
97.0	96.5	96.0	95.5	95.0	93.4
96.9	95.8	95.9	94.6	94.9	92.2
96.8	95.0	95.8	93.6	94.8	90.7
96.7	94.2	95.7	92.5	94.7	89.1
96.6	93.3	95.6	91.3	94.6	87.3
96.5	92.3	95.5	89.9	94.5	85.1
96.4	91.1	95.4	88.4	94.4	82.6
96.3	89.8	95.3	86.7	94.3	79.5
96.2	88.5	95.2	84.8	94.2	75.5
96.1	87.1	95.1	82.7	94.1	69.7
96.0	85.5	95.0	80.3	94.0	60.0
95.9	83.8	94.9	77.6	Under 94.0	REJECT
95.8	82.0	94.8	74.3		
95.7	80.0	94.7	70.6		
95.6	77.7	94.6	66.0		
95.5	75.4	94.5	60.0		
95.4	73.0				
95.3	70.3	Under 94.5	REJECT		
95.2	67.2				
95.1	63.7				
95.0	60.0				
Under 95.0	REJECT				

Actual Density = % of Marshall Density
Pay Factor = % of Contract Price

3.11 SURFACE TOLERANCES

.1 Smoothness:

.1 Maximum variation under 3 m straightedge as follows:

.2 Longitudinal in direction of travel: 3 mm

.3 Transverse to direction of travel: 6 mm

.4 (Straight crossfall)

.2 Grade:

.1 +6 mm maximum variation from designated grade elevations.

.3 .3 Texture:

.1 Finished surface shall have a tightly knit texture free of visible signs of poor workmanship such as, but not limited to:

.2 Segregation

.3 Areas exhibiting excess or insufficient asphalt

.4 Improper matching of longitudinal and transverse joints

.5 Roller marks, cracking or tearing

.4 Defective Surface: If surface and grade tolerances are exceeded, or if surface texture is not met, grind down and resurface defective areas as directed by the Engineer.

3.12 THICKNESS TOLERANCE

.1 The quality assurance laboratory will take three cores from each 1000 m^2 of asphalt pavement suspected to be deficient of the specified total thickness. The average thickness of the three cores represents that area.

.1 If average core thickness is deficient, that area of asphalt pavement will be assessed a pay factor according to the following table to be applied to the price of the top 50 mm of asphalt surface.

ASPHALT THICKNESS PAY FACTORS

THICKNESS DEFICIENCY (mm)	PAY FACTOR (% of Price of Top 50 mm)
6	100.0
7	97.0
8	93.0
9	90.0
10	85.5
11	80.5
12	75.0
13	68.0
14	60.0
15	50.0
Over 15	Grind and resurface

.2 Asphalt pavement with excess thickness may be accepted if surface and grade tolerances and texture are met, but no additional payment is due.

3.13 METHOD OF PENALTY PAYMENT

.1 The penalty for deficient asphalt as calculated per Sections 3.10 to 3.12 will be deducted from payment to the Contractor. Final computation of the penalty may not be completed until the end of the maintenance period. The penalty may therefore take the form of an interim hold back from progress payments to the Contractor.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 05 10 - Corrected Maximum Dry Density for Fill

.2 Section 31 22 13 - Rough Grading

.3 Section 31 23 33.01 - Excavating, Trenching and Backfilling

.4 Section 32 16 15 - Concrete Walks, Curbs and Gutters

.5 Section 32 17 23 - Pavement Marking

1.2 REFERENCES

.1 Alberta Transportation Specifications for Paving.

.2 ASTM International
- .1 ASTM C88-13: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
- .2 ASTM C117-13: Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
- .3 ASTM C123/C123M-14: Standard Test Method for Lightweight Particles in Aggregate.
- .4 ASTM C127-15: Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
- .5 ASTM C128-15: Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
- .6 ASTM C131/C131M-14: Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- .7 ASTM C136/C136M-14: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .8 ASTM D698-12e2: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3).
- .9 ASTM D977-13e1: Standard Specification for Emulsified Asphalt.
- .10 ASTM D1188-07e1: Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
- .11 ASTM D1557-12e1: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3) (2,700 kN-m/m^3).
- .12 ASTM D2172/D2172M-11: Standard Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures.
- .13 ASTM D2419-14: Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
- .14 ASTM D2950/D2950M-14: Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
- .15 ASTM D3203/D3203M-11: Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.

.16 ASTM D4318-10e1: Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
.17 ASTM D4791-10: Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

.3 Asphalt Institute (AI)
.1 AI MS-2-94: Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
.2 AI-MS-8: The Asphalt Institute Paving Manual No. 8, 2nd Edition.

.4 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-8.1-88: Sieves Testing, Woven Wire, Inch Series.
.2 CAN/CGSB-8.2-M88: 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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for asphalt paving mix, aggregate, and coatings and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Samples:
.1 Submit asphalt concrete mix design and trial mix test results for review.
.2 Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least 4 weeks prior to commencing work.
.3 Submit samples of following materials proposed for use at least 4 weeks prior to commencing work:
.1 One 5 L container of asphalt cement.

.4 Test and Evaluation Reports:
.1 Materials to be tested by testing laboratory approved by Departmental Representative.
.2 Submit test certificates showing suitability of materials at least 4 weeks prior to commencing work.
.3 Submit sieve analyses for aggregates to be used in production of paving, and mix design for each asphalt concrete mix required to the Departmental Representative for review.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Storage and Handling Requirements:

.1 Store materials in accordance with manufacturer's recommendations.
.2 Store and protect aggregate from damage.
.3 Replace defective or damaged materials with new.

1.5 PROTECTION

.1 Protect buildings, landscaping, roads, driveways, sidewalks and adjacent property that may be damaged by paving machinery materials, equipment or personnel. Immediately Restore property damage due to paving operations to original condition.

.2 Provide access to buildings as required. Arrange paving schedule so as not to interfere with normal use of premises.

1.6 QUALITY ASSURANCE

.1 Conform to applicable local standards for paving work on public property.

.2 Employ an established paving contractor, with permanent facilities allowing sufficient control of aggregate gradation and mix proportions to ensure conformity with this specification, and the production of a product of uniform quality.

.3 Employ a single subcontractor to proof roll the subgrade, and to construct granular sub-base, crushed gravel base, and paving in all asphalt paved areas.

.4 Determine in place densities in accordance with ASTM D2950, as directed by the Departmental Representative.

2 Products

2.1 MATERIALS

.1 Granular Sub-base Course: Fill Type 2 as specified in Section 31 23 33.01.

.2 Granular Base Course: Fill Type 3 as specified in Section 31 23 33.01.

.3 Asphalt concrete aggregates:
.1 Coarse aggregate is aggregate retained on 4.75 mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C117.
.2 When dryer drum plant or plant without hot screening is used, process fine aggregate through 4.75 mm sieve and stockpile separately from coarse aggregate.
.3 Separate stock piles for coarse and fine aggregate are not required for sheet asphalt.
.4 Do not use aggregates having known polishing characteristics in mixes for surface courses.

.4 Asphalt cement: conforming to Alberta Transportation type S1.

.5 Asphalt prime: Homogeneous medium curing liquid asphalt MC-30 or MC-250 as required.

.6 Tack Coat: SS-1 diluted 50/50.

.7 Sand blotter: clean granular material passing 4.75 mm sieve and free from organic matter or other deleterious materials.

.8 Mineral Filler: Finely ground particles of limestone, hydrated lime, or other approved mineral dust, free of foreign matter.

.9 Seal Coat: Asphalt Institute Manual MS-4, fog type.

2.2 EQUIPMENT

.1 Pavers: mechanical grade controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown indicated.

.2 Rollers: sufficient number of rollers of type and weight to obtain specified density of compacted mix.

.3 Vibratory rollers for parking lots and driveways:
  - .1 Minimum drum diameter: 750 mm.
  - .2 Maximum amplitude of vibration (machine setting): 0.5 mm for lifts less than 40 mm thick.

.4 Haul trucks: of 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.

.5 Suitable hand tools.

2.3 MIX DESIGN

.1 Mix design to AI MS-2 and to Alberta Transportation type S1.

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 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 SUBGRADE PREPARATION AND INSPECTION

.1 Temporary Erosion and Sedimentation Control: as specified in Section 31 23 33.01.

.2 Verify grades of subgrade drains and other items set in paving area for conformity with elevations and sections before placing granular sub-base material.

.3 Prepare and compact subgrades to the requirements specified in Section 31 23 33.01.

.4 Obtain written approval of subgrade by Departmental Representative before placing granular sub-base.

3.3 GRANULAR SUB-BASE AND GRANULAR BASE

.1 Place granular sub-base material on clean unfrozen surface, free from snow and ice. Prepare subgrades as outlined in the Geotechnical Investigation Report, to a depth of 150 mm for light duty paving and 300 mm depth for heavy duty paving.

.2 Place granular sub-base to compacted thicknesses of 250 mm to areas receiving light duty paving and 300 mm to areas receiving heavy duty paving. Do not place frozen material.
    .1 Place in layers not exceeding 150 mm compacted thickness. Compact each layer to density not less than 98% corrected maximum dry density in accordance with ASTM D698.

.3 Over compacted granular sub-base, place granular base to a compacted thickness of 100 mm. Do not place frozen material.
    .1 Compact to a density not less than 100% corrected maximum dry density in accordance with ASTM D698.

.4 Finished base surface to be within 10 mm of specified grade, but not uniformly high or low.

3.4 ASPHALT PRIME

.1 Apply primer at uniform rate of 2.0 L/sq m, to suit grade conditions.

.2 Apply primer in accordance with manufacturer's instructions.

.3 Prime edges of concrete curbs and existing asphalt paving which abuts new paving and concrete curbs and sidewalks.

.4 Coat surfaces of manholes and catch basin frames with oil to prevent bond with asphalt paving.

.5 Do not apply primer when air temperature is below 5 degrees C or when rain is forecast within 2 hours.

.6 If asphalt prime fails to cure within 24 hours, spread sand blotter material in amounts required to absorb excess material. Sweep and remove excess blotter material.

.7 Take necessary measures to prevent soiling of finished concrete and other finished surfaces during priming and remove any asphalt overspray from such surfaces.

3.5 TRANSPORTATION OF ASPHALT HOT MIX

.1 Transport the mixture to the work in vehicles with tight metal boxes, previously cleaned of all foreign materials.

.2 Boxes may be lightly lubricated with an approved thin oil. Do not solvent clean tools or containers which will contact the mix.

.3 During adverse weather conditions, and when air temperature is below 15°C, cover each load with a waterproof tarpaulin of sufficient size for the full protection of the load.

.4 Do not send out loads so late in the day as to prevent spreading and compaction of the mixture during daylight hours unless adequate artificial lighting has been provided and approved.

.5 Ensure that temperature of the mix at the time of discharge into the spreader are as follows, and do not exceed 10°C variance between consecutive loads:
  .1 At site air temperature above 15°C: 115°C to 146°C.
  .2 At site air temperature below 15°C: 137°C to 160°C.

3.6 SPREADING THE MIXTURE

.1 Over the primed gravel base course install a course of asphaltic concrete. Comply with Asphalt Institute AI-MS-8, and the materials, paving mix, workmanship and finished pavement properties fully complying with the Asphalt Institute AI-MS-8.

.2 Place asphalt concrete within 24 h of priming base surfaces.

.3 Lay the mixture on a dry base, under suitable weather conditions, cleaned of all loose or foreign material. Obtain Departmental Representative's acceptance primer prior to placing asphalt.

.4 Apply asphalt in single lifts of specified compacted thicknesses, minimum, laid to indicated elevations and grades.

.5 Place asphalt mix only when base of previous course is dry, and within two hours of placing and compacting binder course.

.6 Do not lay asphalt when the site air temperature is below 5°C.

.7 Spread the mixture for compaction by means of an approved self-propelled mechanical spreader to uniform section depth to result in the minimum thickness specified after consolidation.

.8 Compact each course with roller as soon as it can support roller weight without undue displacement.

.9 Do not place asphalt when the temperature of the surface on which asphalt is placed is less than 5°C.

.10 Carefully make longitudinal and transverse joints, well bonded and sealed. Make joints between old and new pavement or between successive day's work, in such a manner to ensure continuous profile and grade as well as adequate bond.

.11 Where paving is laid in two courses, overlap the horizontal joints 600 mm minimum.

3.7 THICKNESS

.1 Light Duty Paving (to parking stalls): 75 mm compacted thickness of asphalt mix; compacted to 96% of 50 blow Marshall design density.

.2 Heavy Duty Paving: to drive aisles and the like: 100 mm compacted thickness of asphalt mix, compacted to 96% of 50 blow Marshall design density.

3.8 COMPACTION

.1 After spreading, uniformly compact the mixture by an approved steel roller, as soon after spreading as it will bear the roller without undue cracking or displacement.

.2 Overlap rolling in successive trips by at least one-half the width of a rear wheel.

.3 Do not exceed roller speed of 5 km/h nor slow enough to avoid displacement of the mixture. Correct any displacement at once by the use of rakes and addition of fresh mixture.

.4 Continue rolling until all roller marks are eliminated and any further compression is not possible.

.5 Sparingly lubricate roller wheels with water to prevent adhesion of mixture.

.6 Along curbs, headers, manholes, or similar structures or against buildings not accessible to the roller, compact using a vibrating plate compactor or hand tamper, to achieve thorough compaction, with effective seal of all joints.

.7 Finish paving smooth and true to established crown and grade. Immediately remedy low or defective areas either by cutting out and replacing with fresh hot mixture or if approved, by the addition of further hot mixture. Compact such areas to conform with, and bond to, the surrounding area. Ensure paving is flush with adjacent paving to drive aisles.

.8 Slope finished asphalt paving surfaces to drains.

.9 Ensure that the field density of the finished pavement is an average of 96% of the laboratory compacted 50 blow Marshall density of the design mix and 96% minimum at any one location.

3.9 TOLERANCES

.1 Compacted thickness: + 10 mm of design thickness.

.2 Flatness: maximum variation of 6 mm under a 3 m straight edge laid in any direction; no ponding.

.3 Variation of True Elevation: Within 12 mm.

3.10 CONTACT FACES WITH ASPHALT SURFACE

.1 Cut bituminous course to full depth in neat lines to expose fresh vertical surfaces. Remove broken and loose material.

.2 Clean and uniformly paint contact faces of curbs, sidewalks and existing asphalt with new hot asphalt cement or emulsified asphalt primer before placing any asphalt cement mixture to ensure a tight bond between pavement and contact surface.

.3 Carefully place and compact hot asphaltic material against joints.

3.11 PROTECTIVE SEAL COATING

.1 Upon completion of the asphaltic concrete surface course, evenly apply a fog seal coat. Dilute to Asphalt Institute AI-MS-8.

3.12 TESTING

.1 Inspection and testing of asphalt pavement will be carried out by designated testing laboratory in accordance with Section 01 45 00 - Quality Control.

.2 Refer to Section 01 29 83 - Payment Procedures for Testing Laboratory Services for payment for testing agency.

3.13 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
   .1 Leave Work area clean at end of each day.

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

3.14 PROTECTION

.1 Keep vehicular traffic off newly paved areas until paving surface temperature has cooled below 38 degrees C.
   .1 Do not permit stationary loads on pavement until 24 hours after placement.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies the requirements for surface gravel for roads and parking areas that will not be paved.

1.2 RELATED WORK

.1 Refer to Section 31 22 16 - Grading.

1.3 REGULATIONS

.1 Abide by the bylaws and regulations of the Province, Territory or Municipality in which the work is located.

.2 Obtain permission from the Local or Highway Authority for haul routes and abide by the regulations with respect to their maintenance.

1.4 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 - Quality Control.

PART 2 - PRODUCTS

2.1 25 MM MAXIMUM CRUSH

Sieve Size	Percent Passing
25 mm	100
19 mm	95 - 100
9.5 mm	60 - 80
4.75 mm	40 - 60
2.00 mm	25 - 45
425 micro-m	10 - 25
75 micro-m	2 - 10

For crushed aggregate not less than 60 percent of the material retained on the 4.75 mm sieve shall be crushed particles. The ratio of the percentage passing the 4.75 mm sieve to the ratio passing the 425 micro-m sieve shall not exceed two-thirds and preferably not less than one half.

2.2 MINIMUM QUALITY CONTROL TEST FREQUENCIES

.1 The following frequencies of testing are the minimum required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number specified.

.2 Crushed Gravel

.1 One sieve analysis for every 500 m^3 of crushed gravel.

.2 One field density for every 2000 m^2 of compacted layers.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Excavate and dispose of topsoil and objectionable surface materials.

.2 Excavate and remove unsuitable materials in the subgrade and replace with approved embankment material.

3.2 COMPACTION

.1 The Contractor shall compact the gravel to 98% of the maximum density as determined by the Standard Proctor Compaction Test, with approved compaction equipment.

3.3 UTILITIES

.1 Utility appurtenances shall be adjusted to 6 mm - 13 mm below finished surface elevation and protected during the duration of the work.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 23 33.01 - Excavating, Trenching and Backfilling

.2 Section 32 12 16.02 - Asphalt Paving for Building Sites

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM C117-13: Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
- .2 ASTM C136/C136M-14: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .3 ASTM A185/A185M-07: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- .4 ASTM A497/A497M-07: Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
- .5 ASTM A615/A615M-15a: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
- .6 ASTM A1064/A1064M-13: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .7 ASTM C94/C94M-15: Standard Specification for Ready-Mixed Concrete.
- .8 ASTM C260/C260M-10a: Standard Specification for Air-Entraining Admixtures for Concrete.
- .9 ASTM C295/C295M-12: Standard Guide for Petrographic Examination of Aggregates for Concrete.
- .10 ASTM C309-11: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- .11 ASTM C494/C494M-15: Standard Specification for Chemical Admixtures for Concrete.
- .12 ASTM C618-12: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
- .13 ASTM D698-12e2: Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3).
- .14 ASTM D1751-04(2008): Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types.
- .15 ASTM D6690-12: Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-8.1-88: Sieves, Testing, Woven Wire, Inch Series.

.3 Canadian Standards Association (CSA International)
- .1 CSA-A3000-13: Cementitious Materials Compendium.
- .2 CAN/CSA-A23.1-14/A23.2-14: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.3 CAN/CSA-G30.18-09: Billet-Steel Bars for Concrete Reinforcement.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Inform Departmental Representative of proposed source of materials and provide access for sampling at least 4 weeks prior to commencing work.

.3 If materials have been tested by independent testing laboratory approved by Departmental Representative within previous 2 months and have passed tests equal to requirements of this specification, submit test certificates from testing laboratory showing suitability of materials for this project.

.4 Submit product literature for curing compound.

1.4 COORDINATION

.1 Coordinate the work with the local municipal requirements with regard to street and traffic and with the installation of parking meters, hydrants, light standards and power poles as applicable.

2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.2 Reinforcing steel: in accordance with Section 03 20 00 - Concrete Reinforcing.

.3 Joint filler: Asphalt impregnated wood fibreboard type, 19 mm thick, to ASTM D1751.

.4 Granular base: Fill Type 3 as specified in Section 31 23 33.01

.5 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water-soluble soap.

3 Execution

3.1 GRADE PREPARATION

.1 Do grade preparation work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Construct embankments using excavated material free from organic matter or other objectionable materials.

.1 Dispose of surplus and unsuitable excavated material off site.

.3 Place fill in maximum 150 mm layers and compact to at least 98% of maximum dry density to ASTM D698.

3.2 GRANULAR BASE

.1 Obtain Departmental Representative's approval of subgrade before placing granular base.

.2 Place granular base material to lines, widths, and depths as indicated. Install to a compacted depth of 150 mm.

.3 Compact granular base in maximum 150 mm layers to at least 98% of maximum density to ASTM D698.

3.3 FORMING

.1 After obtaining Departmental Representative’s acceptance of adjacent surfaces, set forms in line and grade as indicated on the drawings, free from waves or irregularities in line or grade.

.2 Place and secure forms to correct location, dimension and profile.

.3 Set special forms as required around catch basins, manholes, poles or other objects as indicated on the drawings or as directed by the Departmental Representative.

.4 Place joint filler vertical in position, in straight lines. Secure to form work prior to concrete placement.

.5 Place control joints at 1500 mm o.c., or as otherwise indicated on the drawings. Ensure control joints straight and true to line, and of uniform width.

.6 Place expansion joints at 6000 mm intervals maximum or as otherwise indicated on the drawings. Ensure expansion joints are straight and true to line, and of uniform width.

.7 Align curb, gutter and sidewalk joints.

.8 Form isolation joints around poles, hydrants, manholes and all structures or fixed objects located within the concrete section by using approved bond breaking compound.

.9 Place joint filler between paving components and building or other appurtenances.

.10 Form stairs and ramps to meet all National Building Code of Canada requirements.

.11 Form new curb cuts and driveway accesses to local municipal requirements.

.12 Immediately prior to placement of concrete, carefully inspect all formwork to ensure forms are properly set at required horizontal and vertical alignment, sufficiently rigid, clean and surface treated and ready for placement of concrete.

3.4 REINFORCEMENT

.1 Place reinforcement at mid-depth of slabs-on-grade.

.2 Interrupt reinforcement at expansion joints.

.3 Place reinforcement to achieve slab and curb alignment detailed.

.4 Place 10M rebar transversely 100 mm on each side of all control joints and at sidewalk ends, unless detailed otherwise.

3.5 CONCRETE

.1 Obtain Departmental Representative approval of granular base, formwork and reinforcing steel prior to placing concrete.

.2 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.

.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 Departmental Representative can be demonstrated. Hand finish surfaces when directed by Departmental Representative.

3.6 TOLERANCES

.1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.7 CURING

.1 Cure concrete by adding moisture continuously in accordance with CSA-A23.1/A23.2 to exposed finished surfaces for at least 1 day after placing, or sealing moisture in by curing compound as directed by Departmental Representative.

.2 Where burlap is used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.

.3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.8 BACKFILL

.1 Allow concrete to cure for 7 days prior to backfilling. Backfill to the requirements specified in Section 31 23 33.01

3.9 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for construction of sidewalks, curbs and gutters with slip-form paving machines or concrete extruding machines.

.2 The work includes:

.1 Subgrade cutting and preparation

.2 Placing Concrete

.3 Finishing

.4 Backfilling

1.2 RELATED WORK

.1 Section 32 16 13 - Sidewalk, Curb and Gutter specifies cast-in-place concrete construction, and parts of Section 03 30 00 apply to the work of this section.

.2 Refer to Part 1 General and Items 1.3, 1.4, 1.5, and 1.-6 of Section 32 16 13, which all apply to this specification.

.3 Refer to Part 2 Products and Items 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, and 2.7, of Section 32 16 13 which all apply to this specification.

PART 2 - PRODUCTS

2.1 CONCRETE MIXES

.1 The Engineer will consider the use of special concrete mixes.

.2 Submit complete details to the Engineer for review.

.3 Obtain written approval prior to using special concrete mixes.

2.2 RETEMPERING

.1 If concrete arrives at the site with the concrete slump less than the maximum permitted; the addition of water may be permitted by the Engineer.

.2 Inject water into the mixer under pressure, and in a direction such that the requirements for uniformity specified in ASTM C94-86a are met.

.3 After water is added; mix at least 3 minutes at mixing speed.

.4 Do not add additional water.

.5 Slump, after retempering, shall not exceed the specified limit.

.6 Total time between the initial introduction of mixing water to the cement and aggregates, and the final placing of concrete shall not exceed 90 minutes.

.7 Do not add air entrainment agents or admixtures on site.

PART 3 - EXECUTION

3.1 SUBGRADE

.1 Prepare subgrade as specified in Section 32 16 13.

.2 Equipment used to cut subgrade shall be capable of producing a clean smooth surface. Depth of loose material remaining on the subgrade shall not exceed 13 mm.

3.2 CUSHION

.1 If cushion is required, refer to Section 32 16 13.

3.3 FORMING

.1 Refer to Section 32 16 13.

.2 Extruded curb shall be constructed with a 12:1 sloped face.

3.4 REINFORCING

.1 Refer to the drawings and to Section 32 16 13.

3.5 PLACING CONCRETE

.1 Use extrusion equipment with automatic grade and line control. Submit details regarding equipment, to the Engineer for written approval.

.2 Operation of the extrusion machines shall be continuous until a section or scheduled pour is completed.

.3 The interval between successive loadings of the concrete hopper shall not exceed 30 minutes.

.4 If operations are delayed or stopped, construct a construction joint containing one 10 M reinforcing bar for every 0.3 m width of the structure. Bars shall extend 0.6 m each way from the joint. Do not reuse the excess concrete.

.5 Vibrate to insure a dense smooth concrete, free of honeycombing.

3.6 JOINTS

.1 Refer to Section 32 16 13.

.2 Construction joints may be made by an alternative method provided that cracking is fully controlled, and that the Engineer approves the procedure.

3.7 FINISHING

.1 Limit floating and trowelling to the minimum work required to produce a smooth finish.

.2 If there is evidence of concrete bleeding, delay finishing until the excess water has evaporated.

.3 Remove surplus water from the finish and provide a brush surface. The brush shall be a nylon bristle type.

.4 Tool edges for a width of 25 mm rounded to a radius of 8 mm. Tool edges of contraction and surface joints.

3.8 TOLERANCES

.1 Maximum deviation of surfaces from grades shall not exceed 8 mm. Check all exposed concrete surfaces.

.2 Deviations in alignment at any given point from that given on the survey stakes shall not exceed 25 mm and the fluctuations shall not be greater than 25 mm in any continuous section.

3.9 CROSSINGS

.1 Refer to Section 32 16 13.

3.10 BACKFILL

.1 Refer to Section 32 16 13.

3.11 CURING

.1 Refer to Section 32 16 13.

3.12 NAME PLATE

.1 Refer to Section 32 16 13.

3.13 SEALING

.1 Refer to Section 32 16 13.

3.14 CATCH BASINS AND MANHOLES

.1 Refer to Section 32 16 13.

3.15 COLD WEATHER CONCRETE

.1 Refer to Section 32 16 13.

3.16 CONTINUITY OF WORK

.1 Whenever possible, do the forming and placing of concrete by conventional methods, such as at driveways and corners, in conjunction with the machine construction.

.2 Complete the "handwork" within not later than 7 days of construction of the adjacent extruded section.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 12 16.02 - Asphalt Paving for Building Sites

.2 Section 32 16 15 - Concrete Walks, Curbs and Gutters

.3 Section 32 17 23 - Pavement Marking

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 recycled rubber wheel stops and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.3 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:
- .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect recycled rubber wheel stops from damage.
- .3 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

.1 Recycled Rubber Parking Bumpers: 100% recycled rubber, 100 mm high x 150 mm wide x 1800 mm wide wheel stops, complete with large yellow reflect strips. Provide 5 mooring holes for lag bolts and lag shield and washers. Provide lag bolts, lag sheilds and washers to suit installation.

3 Execution

3.1 INSTALLATION

.1 Install parking bumpers to parking area; one (1) to each parking stall and elsewhere as directed by the Departmental Representative.

.2 Secure in place with steel pins; Set pins flush with top of guard but avoid damage to top of guard.

.3 Align the wheel stops with adjacent curbs to the satisfaction of the Departmental Representative.

3.2 CLEANING

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 12 16.02 - Asphalt Paving for Building Sites

1.2 REFERENCES

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

.2 Master Painters Institute (MPI)
  .1 Architectural Painting Specification Manual - current edition.
    .1 MPI #32 Traffic Markings Paint, Alkyd.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
  .1 Submit manufacturer's printed product literature and data sheets for pavement markings and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operations and Maintenance Data: submit information on materials relative to work of this Section for inclusion in operations and maintenance manual.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:
  .1 Store materials indoors, off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  .2 Store and protect specified materials from freezing and damage.
  .3 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

.1 Paint and Markings:
   - .1 To MPI #32, Alkyd zone/traffic marking.
   - .2 Paints: in accordance with MPI recommendation for surface conditions.
   - .3 Colour: to MPI listed, white or yellow as selected by the Departmental Representative. For handicap symbols, use white and blue.
   - .4 Upon request, Departmental Representative will supply qualified product list of paints applicable to work. Qualified paints may be used but Departmental Representative reserves right to perform further tests.

.2 Thinner: to MPI listed manufacturer.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrates and surfaces to receive pavement markings previously installed under other Sections or Contracts are acceptable for product installation in accordance with MPI instructions prior to pavement markings installation.
   - .1 Visually inspect substrate in presence of Departmental Representative.

.2 Pavement surface: dry, free from water, frost, ice, dust, oil, grease and other deleterious materials.

.3 Proceed with Work only after unacceptable conditions have been rectified.

3.2 EQUIPMENT REQUIREMENTS

.1 Paint applicator: approved pressure type with positive shut-off distributor capable of applying paint in single, double and dashed lines and capable of applying marking components uniformly, at rates specified, and to dimensions as indicated.

3.3 APPLICATION

.1 Pavement markings: lay out pavement markings as indicated on the drawings.

.2 Unless otherwise approved by Departmental Representative, apply paint only when air temperature is above 10 degrees C, wind speed is less than 60 km/h and no rain is forecast within next 4 hours.

.3 Apply traffic paint evenly at rate of 3 m^2/L.

.4 Do not thin paint unless approved by Departmental Representative.

.5 Use stencils for all lines, symbols and lettering.

.6 Symbols and letters to dimensions indicated.

.7 Paint lines of uniform colour and density with sharp edges; 100 mm wide.

.8 Thoroughly clean distributor tank before refilling with paint of different colour.

3.4 TOLERANCE

.1 Paint markings: within plus or minus 12 mm of dimensions indicated.

.2 Remove incorrect markings.

3.5 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
   .1 Leave Work area clean at end of each day.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
   .1 Remove material spilled during installation.

3.6 PROTECTION

.1 Protect pavement markings until dry.

.2 Repair damage to adjacent materials caused by pavement marking application.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 ASTM International
- .1 ASTM A53/A53M-12: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .2 ASTM A90/A90M-13: Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
- .3 ASTM A121-13: Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
- .4 ASTM A123/A123M-13: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .5 ASTM A385/A385M-11: Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
- .6 ASTM A491-11: Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
- .7 ASTM D6386-10: Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.
- .8 ASTM F567-14a: Standard Practice for Installation of Chain-Link Fencing.
- .9 ASTM F626-14: Standard Specification for Fence Fittings.
- .10 ASTM F2611-15: Standard Guide for Design and Construction of Chain Link Security Fencing.

.2 CSA Standards:
- .1 CAN/CSA-A23.1-14/A23.2-14: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.3 CGSB Standards:
- .1 CAN/CGSB-138.1-96: Fabric for Chain Link Fence.
- .2 CAN/CGSB-138.2-96: Steel Framework for Chain Link Fence.
- .3 CAN/CGSB-138.3-96: Installation of Chain Link Fence.
- .4 CAN/CGSB-138.4-96: Gates for Chain Link Fence.
- .5 CAN/CGSB-1.181-99: Ready Mixed Organic Zinc-Rich Coating.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for concrete mixes, fences, posts and gates and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:
- .1 Store materials in accordance with manufacturer's recommendations.
- .2 Store and protect fence and gate materials from damage.
- .3 Replace defective or damaged materials with new.

1.5 PROTECTION

.1 Protect trees, landscaping, bench marks, buildings, pavement and utilities.

.2 Make good all damage and restore to original condition.

2 Products

2.1 MATERIALS

.1 Concrete mixes and materials: in accordance with CSA A23.1 and Section 03 30 00 - Cast-in-Place Concrete.
- .1 Nominal coarse aggregate size: 20-5.
- .2 Compressive strength: 20 MPa minimum at 28 days.
- .3 Additives: fly ash to ASTM C618.

.2 Chain-link fence fabric: to CAN/CGSB-138.1.
- .1 Type 1, Class A, heavy style, Grade 1 or 2.
- .2 Height of fabric: 1.83 m.

.3 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe. Dimensions as indicated.

.4 Bottom tension wire: to CAN/CGSB-138.2, single strand, galvanized steel wire.

.5 Tie wire fasteners: steel wire.

.6 Tension bar: to ASTM A653/A653M, 5 x 20 mm minimum galvanized steel.

.7 Gates: to CAN/CGSB-138.4.

.8 Gate frames: to ASTM A53/A53M, galvanized steel pipe, standard weight 45 mm outside diameter pipe for outside frame, 35 mm outside diameter pipe for interior bracing.
- .1 Fabricate gates as indicated with electrically welded joints, and hot-dip galvanized after welding.
- .2 Fasten fence fabric to gate with twisted selvage at top.

.3 Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.
.4 Furnish double gates with chain hook to hold gates open and centre rest with drop bolt for closed position.

.9 Fittings and hardware: to CAN/CGSB-138.2, galvanized steel or ductile cast iron.
.1 Tension bar bands: 3 x 20 mm minimum galvanized steel or 5 x 20 mm minimum aluminum.
.2 Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail.
.3 Turnbuckles to be drop forged.

.10 Organic zinc rich coating: to CAN/CGSB-1.181.

.11 Grounding rod: 16 mm diameter copperwell rod, 3 m long.

2.2 FINISHES

.1 Galvanizing:
.1 For chain link fabric: to CAN/CGSB-138.1 Grade 2.
.2 For pipe: 550 g/m^2minimum to ASTM A90.
.3 For other fittings: to ASTM A123/A123M.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for fence and gate 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

.1 Temporary Erosion and Sedimentation Control: as specified in Section 31 23 33.01.

.2 Grading:
.1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.
.1 Provide clearance between bottom of fence and ground surface of 30 mm to 50 mm.

3.3 ERECTION OF FENCE

.1 Erect fence along lines as indicated and to CAN/CGSB-138.3.

.2 Excavate post holes 1000 mm depth x 250 mm diameter for line posts, and 1500 mm depth x 400 mm diameter for straining, gate, end and corner posts.

.3 Space line posts maximum 3 m apart or as otherwise indicated, measured parallel to ground surface.

.4 Space straining posts at equal intervals not to exceed 150 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 150 m.

.5 Install additional straining posts at sharp changes in grade and where directed by Departmental Representative.

.6 Install corner post where change in alignment exceeds 10 degrees.

.7 Install end posts at end of fence and at buildings.
 .1 Install gate posts on both sides of gate openings.

.8 Place concrete in post holes then embed posts into concrete to within 150 mm of bottom of post holes.
 .1 Extend concrete 50 mm above ground level and slope to drain away from posts.
 .2 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.

.9 Install fence fabric after concrete has cured, minimum of 5 days.

.10 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface.
 .1 Install braces on both sides of corner and straining posts in similar manner.

.11 Install top caps.

.12 Install top rail between posts and fasten securely to posts and secure waterproof caps.

.13 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.

.14 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.
 .1 Knuckled selvedge at bottom.
 .2 Twisted selvedge at top.

.15 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals.
 .1 Give tie wires minimum two twists.

.16 Install grounding rods as indicated.

3.4 INSTALLATION OF GATES

.1 Install gates in locations as indicated or as otherwise directed by the Departmental Representative.

.2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.

.3 Determine position of centre gate rest for double gate.
  .1 Cast gate rest in concrete as directed.
  .2 Dome concrete above ground level to shed water.

.4 Install gate stops where indicated.

3.5 TOUCH UP

.1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas.
  .1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.6 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  .1 Leave Work area clean at end of each day.

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 23 33.01 - Excavating, Trenching and Backfilling

1.2 REFERENCES

.1 ASTM Standards:
  - .1 ASTM C33/C33M-13: Standard Specification for Concrete Aggregates.
  - .2 ASTM C90-14: Standard Specification for Load-Bearing Concrete Masonry Units.
  - .3 ASTM C140/C140M-15: Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
  - .4 ASTM C150/C150M-15: Standard Specification for Portland Cement.
  - .5 ASTM C595/C595M-15e: Standard Specification for Blended Hydraulic Cements.
  - .6 ASTM C1262-10: Standard Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units.
  - .7 ASTM C1372-14a: Standard Specifications for Segmental Retaining Wall Units.
  - .8 ASTM D422-63(2007)e2: Standard Test Method for Particle-Size Analysis of Soils.
  - .9 ASTM D698-12e2: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
  - .10 ASTM D3034-14a: Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - .11 ASTM D4751-12: Standard Test Method for Determining Apparent Opening Size of a Geotextile.

.2 Engineering Design:
  - .1 NCMA Design Manual for Segmental Retaining Walls, Second Edition.
  - .2 NCMA TEK 2-4: Specifications for Segmental Retaining Wall Units.
  - .3 NCMA SRWU-2: Determination of Shear Strength between Segmental Concrete Units.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:
  - .1 Submit shop drawings of modular concrete retaining walls including caps, special shapes and accessories.
  - .2 Shop drawings of modular concrete retaining walls are to be signed and sealed by a professional Engineer registered in the province of Alberta, and qualified in the area of segmental retaining wall design and construction.

.3 The Contractor’s Engineer will perform the following tasks:

.1 Design and produce signed and sealed shop drawings and detailed design calculations for complete modular concrete retaining wall.
.2 Review the site soil and geometric conditions to ensure the designed wall is compatible with the site prior to construction.
.3 Inspect the site conditions, materials incorporated into the retaining wall, and the construction practices used during the construction.
.4 Provide the Departmental Representative with a letter after completion, certifying the design meets the requirements of this specification, the design was compatible with the site and the wall was constructed according to design.

.4 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for modular retaining walls and include product characteristics, performance criteria, physical size, finish and limitations.

.5 Samples:
.1 Provide duplicate samples of modular concrete retaining wall units and caps and related accessories.

.6 Materials Submittals: Manufacturer’s certifications, stating that the modular concrete retaining wall units and imported aggregates and soils meet the requirements of this specification and the Contractor’s Engineer’s design.

.7 Manufacturer's Instructions: submit manufacturer's installation instructions.

1.4 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for modular retaining walls for incorporation into manual.

1.5 QUALIFICATIONS

.1 Installer Qualifications: The Modular Concrete retaining wall Subcontractor must be able to demonstrate that their field construction supervisor has the necessary experience for the project by providing documentation showing that they have successfully completed projects of similar scope and size.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:
.1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Store and protect modular retaining wall components from damage.
.3 Protect prefinished surfaces with wrapping.
.4 Replace defective or damaged materials with new.

2 Products

2.1 MODULAR WALL UNITS

.1 Acceptable Products:
.1 Allan Block Original Retaining Wall units as distributed by CCI.
.2 Pisa II Retaining Wall units as distributed by Expocrete Concrete Products Ltd.
.3 Other preapproved product.

.2 Provide wall units having minimum 28 day compressive strength of 20.7 MPa in accordance with ASTM C1372. Ensure the concrete units have adequate freeze-thaw protection with an average absorption rate of 120 kg/m^3.

.3 Ensure exterior dimensions are uniform and consistent. Do not exceed maximum dimensional deviations of 3 mm, not including textured face.

.4 Provide wall units with a minimum of 1,761 kg/m^3 of wall face area. Fill contained within the units may be considered 80% effective weight.

.5 Provide all cap units, special shapes and accessories as required.

.6 Exterior face: textured. Colour as selected by the Departmental Repesentative.

2.2 BACKFILL MATERIALS

.1 Ensure base material is well-graded compactable aggregate, 6.4 mm - 38 mm, with no more than 10% passing the #200 sieve.

.2 Provide drainage material the same as base material or as otherwise indicated on the reviewed shop drawings.

.3 Use Fill Type 1 as specified in Section 31 23 33.01 for backfill material when accepted by the Departmental Representative unless otherwise specified in the drawings. Do not use unsuitable soils for backfill (heavy clays or organic soils) in the reinforced soil mass.

.4 Where additional fill is required, submit sample and specifications to the Departmental Representative for acceptance.

.5 Definitions:
.1 Retained soil: on site soils unless otherwise indicated on the reviewed shop drawings.
.2 Foundation soil: the native undisturbed on Fill Type 1. Ensure the foundation soil has been reviewed and accepted by the Contractor’s Engineer prior to the placement of the base material.

2.3 ACCESSORIES

.1 Drainage Pipe: perforated corrugated HDPE or PVC pipe, with a minimum diameter of 100 mm, protected by a geotextile filter to prevent the migration of soil particles into the pipe, or as indicated on the reviewed shop drawings.

.2 Geotextile Filter: install non-woven geotextile as specified on the reviewed shop drawings. Use geotextile for filtration with an Apparent Opening Size ranging between 0.149 and 0.210 mm (U.S. Sieve Sizes 100 to 70) and a minimum unit weight of 135 grams per square metre. The coefficient of permeability to be between 0.1 and 0.3 cm/second.

.3 Concrete Adhesive: as recommended by the manufacturer to permanently secure the coping stone to the top course of the wall. The adhesive must provide sufficient strength and remain flexible.

3 Execution

3.1 INSPECTION

.1 The Contractor’s Engineer is responsible for verifying that all the requirements of the specification are met. This includes the use of approved materials and their proper installation.

3.2 CONSTRUCTION TOLERANCES

.1 The following tolerances are the maximum allowable deviation from the planned construction:
  - .1 Vertical Control: +/- 32 mm over a 3 m distance, +/- 75 mm total.
  - .2 Horizontal Control: +/- 32 mm over a 3 m distance, +/- 75 mm total.
  - .3 Rotation: +/- 2 degrees from planned wall batter.
  - .4 Bulging: 25 mm over a 3 m distance.

3.3 EXCAVATION

.1 Excavate to the lines and grades shown on the construction drawings. Use caution not to over-excavate beyond the lines shown, or to disturb the base elevations beyond those shown.

.2 Refer to Section 31 23 33.01 for additional excavation requirements.

3.4 FOUNDATION SOIL PREPARATION

.1 Proof roll the foundation soil as specified in Section 31 23 33.01, and have the Contractor’s Engineer review to ensure that it meets the minimum strength requirements according to the design assumptions. If unacceptable foundation soil is encountered, excavate the affected areas and replace with suitable quality material under the direction of the Contractor’s Design Engineer.

.2 In cut situations, excavate the native soil to the lines and grades indicated on the reviewed shop drawings and removed from the site or stockpiled for reuse for backfilling.

.3 Excavate foundation soil as dimensioned on the drawings and reviewed shop drawings and compacted to a min. 90% Standard Proctor Maximum Dry Density prior to placement of the base material.

.4 Have the Contractor’s Engineer examine foundation soil to insure that the actual foundation soil strength meets or exceeds assumed design strength. Remove soil not meeting the required strength and replace with acceptable material.

3.5 INSTALLATION/DRAINAGE SYSTEM

.1 Set the approved non-woven geotextile against the back of the first retaining wall unit, over the prepared foundation, and extend towards the back of the excavation, up the excavation face and back over the top of the drainage material to the retaining wall, or as otherwise indicated on the reviewed shop drawings.

.2 Place the drainage pipe behind the levelling base, or lower course of facing units as indicated on the reviewed shop drawings or as otherwise directed by the Contractor’s Design Engineer. Lay the pipe at a minimum gradient of 2% to ensure adequate drainage to free outlets.

.3 Install T - Sections and outlet pipes on the drainage pipe at 15 m centres or as indicated on the reviewed shop drawings.

.4 Pull the remaining length of geotextile taut and pin over the face of the retained soil. Overlap geotextile a minimum of 300 mm and shingle down the face of the excavation in order to prevent the infiltration of retained soil into the drainage layer.

3.6 BASE

.1 Place base material as indicated on reviewed shop drawing. Locate top of base to allow bottom wall units to be buried to proper depths as per wall heights and specifications.

.2 Install base material on undisturbed native soils or suitable replacement fills compacted at 90% Standard Proctor Maximum Dry Density.

.3 Compact bases at 90% Standard Proctor Maximum Dry Density to provide a level hard surface on which to place the first course of blocks. Construct base to insure proper wall embedment and the final elevation shown on the plans. Well-graded sand may be used to smooth the top 13 mm on the levelling pad.

.4 Place base material to a minimum depth of 150 mm.

3.7 UNIT INSTALLATION

.1 Place the bottom row of retaining wall modules on the prepared levelling base as indicated on the reviewed shop drawings.

.2 Place the first course of wall units on the prepared base with the raised lip facing out and the front edges tight together. Check the units for level and alignment as they are placed.

Take care to ensure that the wall modules are aligned properly, levelled from side to side and front to back and are in complete contact with the base material.

.3 Insure that units are in full contact with base. Take proper care to develop straight lines and smooth curves on base course as per wall layout.

.4 Where indicated, install modular concrete retaining walls to smooth uniform curvature to radii indicated on the drawings.

.5 Fill all cavities in and around the base row base materials and compact. Backfill front and back of entire base row to firmly lock in place. Check again for level and alignment. Sweep all excess material from top of units.

.6 Install next course of wall units on top of base row. Position blocks to be offset from seams of blocks below. Perfect "running bond" is not essential, but a 375 mm minimum offset is recommended. Check each block for proper alignment and level. Fill all cavities in and around wall units and to a 305 mm depth behind block with drainage material. Spread backfill in uniform lifts not exceeding 200 mm in uncompacted thickness and compact to 90% of Standard Proctor Maximum Dry Density. Employ methods using lightweight compaction equipment that will not disrupt the stability or batter of the wall. Use only hand-operated plate compaction equipment within 900 mm of wall face.

.7 For the Pisa II units, place the wall modules above the bottom course such that the tongue and grove arrangement provides the design batter (i.e. setback) of the wall face. Place successive courses to create a running bond pattern with the edge of all units being approximately aligned with the middle of the unit in the course below it.

.8 Install each subsequent course in like manner. Repeat procedure to the extent of wall height.

.9 Allowable construction tolerance at the wall face is 2 degrees vertically and 25 mm in 3 m horizontally, unless indicated otherwise.

.10 Sweep the wall modules clean before placing additional levels to ensure that no dirt, concrete or other foreign materials become lodged between successive lifts of the wall modules.

.11 Place a maximum of 4 courses of wall units above the level of the drainage material at any time.

.12 Check the level of wall modules with each lift to ensure that no gaps are formed between successive lifts.

.13 Take care to ensure that the wall are not broken or damaged during handling and placement.

3.8 DRAINAGE SOIL

.1 Place the drainage soil behind the retaining wall modules with a minimum width of 300 mm and separated from other soils using the approved non-woven geotextile.

.2 Place drainage soil behind the wall facing in maximum lifts of 150 mm and compacted to a minimum density of 95% Standard Proctor Maximum Dry Density.

.3 Do not use heavy compaction equipment within 1 metre of the back of the wall facia.

3.9 RETAINED SOIL

.1 Place and compacted retained soils behind the drainage material in maximum lift thickness of 150 mm. Use undisturbed native material or engineered fill for retained soil, compacted to a minimum density of 95% Standard Proctor Maximum Dry Density.

.2 Do not use heavy compaction equipment within 1 metre of the back of the wall modules.

3.10 FINISHING WALL

.1 Secure cap and coping units to the top of the wall with two 10 mm beads of the approved flexible concrete adhesive positioned 50 mm in front and behind the tongue of the last course of retaining wall units or as otherwise recommended by the manufacturer.

.2 Finish grading above the wall to direct surface run off water away from the segmental retaining wall. Use a soil with a low permeability to restrict the rate of water infiltration into the retaining wall structure.

.3 Install caps, special shapes and accessories in accordance with manufacturer's recommendations.

3.11 CLEANING

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

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 31 22 13 - Rough Grading

.2 Section 31 23 33.01 - Excavating, Trenching and Backfilling

.3 Section 32 92 19.16 - Hydraulic Seeding

.4 Section 32 92 23 - Sodding

.5 Section 32 93 10 - Trees, Shrubs and Ground Cover Planting

1.2 TESTING

.1 Testing of topsoil: Departmental Representative will pay for cost of tests as specified in Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

1.3 REFERENCES

.1 Agriculture and Agri-Food Canada
   - .1 The Canadian System of Soil Classification, Third Edition, 1998.

.2 Canadian Council of Ministers of the Environment
   - .1 PN1340-2005, Guidelines for Compost Quality.

1.4 DEFINITIONS

.1 Compost:
   - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.
   - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
   - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below (25) (50)), and contain no toxic or growth inhibiting contaminates.
   - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A) (B).

1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Quality control submittals :
   - .1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.

.2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.3 Mix sample soils thoroughly, containerize and label to include:
.1 Origin of Material
.2 Intended use
.3 Name and Job No. of Project.

1.6 QUALITY ASSURANCE

.1 Pre-installation meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.

2 Products

2.1 TOPSOIL

.1 Original topsoil from on site excavation: re-use topsoil stripped from site if it meets or is conditioned to meet the requirements of paragraph 2.1.2 below.

.2 Topsoil (imported): natural, fertile, friable, agricultural soil containing not less than 6% of organic material with pH value ranging from 5.0 to 7.0. Salinity level for imported topsoil must not exceed 1.5. Soil reasonably free from subsoil, slag, clay, stone, lumps, live plants, roots, sticks, quack-grass, noxious weeds and foreign matter. Note: provide imported top soil only if there is insufficient quantity of native topsoil to fulfil landscaping requirements.

2.2 SOIL AMENDMENTS

.1 Fertilizer:
.1 Fertility: major soil nutrients present in following amounts:
.2 Nitrogen (N): 20 to 40 micrograms of available N per gram of topsoil.
.3 Phosphorus (P): 40 to 50 micrograms of phosphate per gram of topsoil.
.4 Potassium (K): 75 to 110 micrograms of potassium per gram of topsoil.
.5 Calcium, magnesium, sulfur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
.6 Ph value: 6.5 to 8.0.

.2 Peatmoss:
.1 Derived from partially decomposed species of Sphagnum Mosses.
.2 Elastic and homogeneous, brown in colour.
.3 Free of wood and deleterious material which could prohibit growth.
.4 Shredded particle minimum size: 5 mm.

.3 Sand: washed coarse silica sand, medium to course textured.

.4 Organic matter: compost Category A, B in accordance with CCME PN1340, unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.

.5 Use composts meeting Category B requirements for land fill reclamation and large scale industrial applications.

.6 Limestone:
  .1 Ground agricultural limestone.
  .2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.

.7 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

2.3 SOURCE QUALITY CONTROL

.1 Advise Departmental Representative of sources of topsoil to be utilized with sufficient lead time for testing.

.2 Contractor is responsible for amendments to supply topsoil as specified.

.3 Soil testing by recognized testing facility for PH, P and K, and organic matter.

.4 Testing of topsoil will be carried out by testing laboratory designated by Departmental Representative.
  .1 Soil sampling, testing and analysis to be in accordance with Provincial standards.

3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Conform to temporary erosion and sedimentation requirements specified in Section 31 23 33.01.

.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 Strip existing topsoil as specified in Section 31 23 33.01.

3.3 PREPARATION OF EXISTING GRADE

.1 Verify that grades are correct.
  .1 If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.

.2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.

.3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
  .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
  .2 Remove debris which protrudes more than 75 mm above surface.
  .3 Dispose of removed material off site.

.4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.
  .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

3.4 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL

.1 Place topsoil after Departmental Representative has accepted subgrade.

.2 Spread topsoil in uniform layers not exceeding 150 mm.

.3 For sodded areas keep topsoil 15 mm below finished grade.

.4 Spread topsoil to following minimum depths after settlement.
  .1 150 mm for seeded areas.
  .2 135 mm for sodded areas.
  .3 300 mm for flower beds.
  .4 500 mm for shrub beds.

.5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.5 SOIL AMENDMENTS

.1 For planting beds and turf : apply and thoroughly mix soil amendments into full specified depth of topsoil and top 50 mm of existing soil at rates recommended by the soil amendment manufacturer to suit topsoil.

3.6 FINISH GRADING

.1 Grade to eliminate rough spots and low areas and ensure positive drainage.
  .1 Prepare loose friable bed by means of cultivation and subsequent raking.

.2 Consolidate topsoil to required bulk density using equipment approved by Departmental Representative.
  .1 Leave surfaces smooth, uniform and firm against deep footprinting.

.3 Where new topsoil meets existing landscaping to remain, blend new topsoil into existing to provide for a smooth transition.

.4 Re-grade existing areas as noted on the drawings.

3.7 ACCEPTANCE

.1 Departmental Representative will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

3.8 SURPLUS MATERIAL

.1 Dispose of materials except topsoil not required off site.

3.9 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 91 19.13 - Topsoil Placement and Grading

.2 Section 32 92 19.16 - Hydraulic Seeding

.3 Section 32 92 23 - Sodding

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.

.2 Scheduling:
  - .1 Schedule hydraulic seeding to coincide with preparation of soil surface.
  - .2 Schedule hydraulic seeding using grass mixtures and mixtures containing Crownvetch or Trefoil between dates recommended by Provincial Agricultural Department.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for seed, mulch, tackifier, fertilizer, liquid soil amendments and micronutrients.
  - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Submit in writing 7 days prior to commencing work:
  - .1 Volume capacity of hydraulic seeder in litres.
  - .2 Amount of material to be used per tank based on volume.
  - .3 Number of tank loads required per hectare to apply specified slurry mixture per hectare.

.4 Samples:
  - .1 Submit 0.5 kg container of each type of fertilizer used.

.5 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.6 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

1.4 QUALITY ASSURANCE

.1 Qualifications:
  .1 Landscape Contractor: to be a Member in Good Standing of Provincial Horticultural Trades Association.
  .2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
  .3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements:
  .1 Labelled bags of fertilizer identifying mass in kg, mix components and percentages, date of bagging, supplier's name and lot number.
  .2 Inoculant containers to be tagged with expiry date.

.3 Storage and Handling Requirements:
  .1 Store fertilizer off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  .2 Replace defective or damaged materials with new.

1.6 WARRANTY

.1 For seeding, 12 months warranty period is extended to 24 months.

.2 End-of-warranty inspection will be conducted by Departmental Representative.

2 Products

2.1 MATERIALS

.1 Seed: "Canada pedigreed grade" in accordance with Government of Canada Seeds Act and Regulations.
  .1 Grass mixture: "Certified", "Canada No. 1 Lawn Grass Mixture" in accordance with Government of Canada "Seeds Act" and "Seeds Regulations".

    .1 Mixture composition:
      .1 Kentucky Bluegrass:....................20%
      .2 Creeping Red Fescue:....................30%
      .3 Crested Wheat:....................35%
      .4 Perennial Rye:....................15%

.2 Mulch: use net air dry mass of fibre mulch as determined in accordance with Canadian Pulp and Paper section, Standard A2. Free of growth-inhibiting ingredients. Capable of dispersing in water to form homogeneous slurry. Capable of forming an absorptive mat ground cover allowing water percolation. Wood or wood cellulose fiber.

.3 Tackifier: water dilutable liquid dispersion containing polyvinyl acetate terpolymer emulsion or colloidal polyacharide tackifier, adhering to mulch during manufacturing, non toxic and without growth or germination inhibiting factors.

.4 Water: free of impurities that would inhibit germination and growth.

.5 Fertilizer:
- .1 To Canada "Fertilizers Act" and Regulations.
- .2 Type 1: complete synthetic, with minimum 65% water soluble nitrogen. Ratio: 1:4:4.
- .3 Type 2: complete synthetic, slow release, with maximum 35% water soluble nitrogen. Ratio: 2:1:1.

.6 Inoculants: inoculant containers to be tagged with expiry date.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for hydraulic seeding 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLERS

.1 Use installers members in Good Standing of Alberta Horticultural Trades Association.

3.3 PROTECTION OF EXISTING CONDITIONS

.1 Protect structures, signs, guide rails, fences, plant material, utilities and other surfaces not intended for spray.

.2 Immediately remove any material sprayed where not intended as directed by Departmental Representative.

3.4 PREPARATION OF SURFACES

.1 Do not perform work under adverse field conditions such as wind speeds over 10 km/h, frozen ground or ground covered with snow, ice or standing water.

.2 Fine grade areas to be seeded free of humps and hollows.
- .1 Ensure areas are free of deleterious and refuse materials.

.3 Cultivated areas identified as requiring cultivation to depth of 50 mm.

.4 Ensure areas to be seeded are moist to depth of 150 mm before seeding.

.5 Obtain Departmental Representative's approval of grade and topsoil depth before starting to seed.

3.5 FERTILIZING

.1 Apply fertilizer type 1 at a rate recommended by manufacturer. Apply after fine grading and prior to compaction. Mix thoroughly into upper 50 mm of topsoil.

.2 Lightly water to aid the breakdown of fertilizer.

.3 Apply fertilizer 48 hours before Hydraulic-seeding.

3.6 PREPARATION OF SLURRY

.1 Measure quantities of materials by weight or weight-calibrated volume measurement satisfactory to Departmental Representative. Supply equipment required for this work.

.2 Charge required water into seeder. Add material into hydraulic seeder under agitation. Pulverize mulch and charge slowly into seeder.

.3 After materials are in seeder and well mixed, charge tackifier into seeder and mix thoroughly to complete slurry.

3.7 SLURRY APPLICATION

.1 Ensure seed is placed under supervision of certified Landscape Planting Supervisor.

.2 Hydraulic seeding equipment:
  - .1 Slurry tank.
  - .2 Agitation system for slurry to be capable of operating during charging of tank and during seeding, consisting of recirculation of slurry and/or mechanical agitation method.
  - .3 Capable of seeding by 50 m hand operated hoses and appropriate nozzles.
  - .4 Tank volume to be certified by certifying authority and identified by authorities "Volume Certification Plate".

.3 Slurry mixture applied per hectare.
  - .1 Seed: 300 kg/Ha.
  - .2 Mulch: apply at a rate of 1400 to 200 kg/Ha depending on slope and as recommended by the supplier.
  - .3 Tackifier: apply at the rate of 50 to 100 kg/Ha depending on the slope and as recommended by the supplier.
  - .4 Fertilizer: apply at rate as recommended by the supplier.
  - .5 Water: quantity as required to form slurry in accordance with manufacturers' recommendations.

.4 Apply slurry uniformly, at optimum angle of application for adherence to surfaces and germination of seed.
  .1 Using correct nozzle for application.
  .2 Using hoses for surfaces difficult to reach and to control application.

.5 Blend application 300 mm into adjacent grass areas or sodded areas and previous applications to form uniform surfaces.

.6 Re-apply where application is not uniform.

.7 Remove slurry from items and areas not designated to be sprayed.

3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  .1 Leave Work area clean at end of each day.
  .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
  .1 Clean and reinstate areas affected by Work.

3.9 PROTECTION

.1 Protect seeded areas from trespass until plants are established.

.2 Remove protection devices as directed by Departmental Representative.

3.10 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Ensure maintenance is curried out under supervision of certified Landscape Maintenance Supervisor.

.2 Perform following operations from time of seed application until acceptance by Departmental Representative.

.3 Grass Mixture:
  .1 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
  .2 Mow grass to 50 mm whenever it reaches height of 70 mm. Remove clippings which will smother grass.
  .3 Fertilize seeded areas after 10 weeks after germination provided plants have mature true leafs in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles; water in well.
  .4 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.
  .5 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.

3.11 ACCEPTANCE

.1 Seeded areas will be accepted by Departmental Representative provided that:
  .1 Seeded areas are firmly established, free of rutted, eroded, bare or dead spots.
  .2 Areas have been mown at least twice.
  .3 Areas have been fertilized.

.2 Areas seeded in fall will achieve final acceptance in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.12 MAINTENANCE DURING WARRANTY PERIOD

.1 Perform following operations from time of acceptance until end of warranty period:
  .1 Repair and reseed dead or bare spots to satisfaction of Departmental Representative.
  .2 Mow areas seeded, remove clippings that will smother grassed areas, as directed by Departmental Representative.
  .3 Fertilize seeded areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 91 19.13 - Topsoil Placement and Grading

.2 Section 32 92 19.16 - Hydraulic Seeding

1.2 ADMINISTRATIVE REQUIREMENTS

.1 Scheduling:
- .1 Schedule sod laying to coincide with preparation of soil surface.
- .2 Schedule sod installation when frost is not present in ground.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19 - Project Meetings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
- .1 Submit manufacturer's instructions, printed product literature and data sheets for sod and fertilizer and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Samples.
- .1 Submit:
  - .1 Sod for each type specified.
    - .1 Install approved samples in1 square metre mock-ups and maintain in accordance with maintenance requirements during establishment period.
  - .2 Bio-degradable geotextile fabric.
  - .3 0.5 kg container of each type of fertilizer used.
- .2 Obtain approval of samples by Departmental Representative.

.4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements of seed mix, seed purity, and sod quality.

.5 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties of seed mix, seed purity, and sod quality.

1.4 QUALITY ASSURANCE

.1 Qualifications:

.1 Landscape Contractor: to be a Member in Good Standing of Alberta Horticultural Trades Association.
.2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
.3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:
.1 Store materials in accordance with supplier's recommendations.
.2 Replace defective or damaged materials with new.

2 Products

2.1 MATERIALS

.1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
.1 Turf Grass Nursery Sod types:
.1 Number One Kentucky Bluegrass Sod: Nursery Sod grown solely from seed of cultivars of Kentucky Bluegrass, containing not less than 50% Kentucky Bluegrass cultivars.
.2 Number One Kentucky Bluegrass Sod - Fescue Sod: Nursery Sod grown solely from seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivar.
.3 Number One Named Cultivars: Nursery Sod grown from certified seed.
.2 Turf Grass Nursery Sod quality:
.1 Not more than 1 broadleaf weed and up to 1% native grasses per 40 square metres.
.2 Density of sod sufficient so that no soil is visible from height of 1500 mm when mown to height of 50 mm.
.3 Mowing height limit: 35 to 65 mm.
.4 Soil portion of sod: 6 to 15 mm in thickness.

.2 Sod establishment support:
.1 Wooden pegs: 17 x 8 x 200 mm.
.2 Biodegradable starch pegs: 17 x 8 x 200 mm.

.3 Water:
.1 Supplied by Departmental Representative at designated source.

.4 Fertilizer:
   .1 To Canada "Fertilizers Act" and Fertilizers Regulations.
   .2 Complete, synthetic, slow release with 65 % of nitrogen content in water-insoluble form.

2.2 SOURCE QUALITY CONTROL

.1 Obtain written approval from Departmental Representative of sod at source.

.2 When proposed source of sod is approved, use no other source without written authorization from Departmental Representative.

3 Execution

3.1 INSTALLERS

.1 Use installers who are Member in Good Standing of Alberta Horticultural Trades Association.

3.2 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sod 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 and after receipt of written approval to proceed from Departmental Representative.

3.3 PREPARATION

.1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13 - Topsoil Placement and Grading. If discrepancies occur, notify Departmental Representative and commence work when instructed by Departmental Representative.

.2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.

.3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8 mm, for Turf Grass Nursery Sod, surface to drain naturally.

.4 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site.

3.4 SOD PLACEMENT

.1 Ensure sod placement is done under supervision of certified Landscape Planting Supervisor.

.2 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.

.3 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.

.4 Roll sod as directed by Departmental Representative. Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

3.5 SOD PLACEMENT ON SLOPES AND PEGGING

.1 Start laying sod at bottom of slopes.

.2 Peg sod on slopes steeper than 3 horizontal to 1 vertical, within 1 m of catch basins and within 1 m of drainage channels and ditches to following pattern:
   .1 100 mm below top edge at 200 mm on centre for first sod sections along contours of slopes.
   .2 Not less than 3-6 pegs per square metre.
   .3 Not less than 6-9 pegs per square metre in drainage structures. Adjust pattern as directed by Departmental Representative.
   .4 Drive pegs to 20 mm above soil surface of sod sections.

3.6 FERTILIZING APPLICATION

.1 Apply fertilizer at rate recommended by the manufacturer.

.2 Spread evenly with calibrated mechanical distributer.

.3 Lightly water to aid the breakdown of fertilizer.

3.7 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
   .1 Leave Work area clean at end of each day.
   .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
   .1 Clean and reinstate areas affected by Work.

3.8 PROTECTION BARRIERS

.1 Protect newly sodded areas from deterioration with snow fence on rigid frame as directed by Departmental Representative.

.2 Remove protection after inspection as directed by Departmental Representative.

3.9 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Perform following operations from time of installation until acceptance.
  .1 Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 100 mm.
  .2 Cut grass to 50 mm when or prior to it reaching height of 75 mm.
  .3 Maintain sodded areas weed free 95%.
  .4 Fertilize areas in accordance with fertilizer manufacturer's directions. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
  .5 Temporary barriers or signage to be maintained where required to protect newly established sod.

3.10 ACCEPTANCE

.1 Turf Grass Nursery Sod areas will be accepted by Departmental Representative provided that:
  .1 Sodded areas are properly established.
  .2 Sod is free of bare and dead spots.
  .3 No surface soil is visible from height of 1500 mm when grass has been cut to height of 50 mm.
  .4 Sodded areas have been cut minimum 2 times prior to acceptance.

.2 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

.3 When environmental conditions allow, all sodded areas showing shrinkage cracks shall be top-dressed and seeded with a seed mix matching the original.

.4 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

3.11 MAINTENANCE DURING WARRANTY PERIOD

.1 Perform following operations from time of acceptance until end of warranty period:

  .1 Water sodded Turf Grass Nursery Sod areas at weekly intervals to obtain optimum soil moisture conditions to depth of 100 mm.

.2 Repair and resod dead or bare spots to satisfaction of Departmental Representative.

.3 Cut grass and remove clippings that will smother grass as directed by Departmental Representative to height as follows:
  .1 Turf Grass Nursery Sod:
    .1 50 mm during normal growing conditions.
  .2 Cut grass at 2 week intervals or as directed by Departmental Representative, but at intervals so that approximately one third of growth is removed in single cut.

.3 Fertilize areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.

.4 Eliminate weeds by mechanical means to extent acceptable to Departmental Representative.

END OF SECTION

1 General

1.1 RELATED REQUIREMENTS

.1 Section 32 91 19.13 Topsoil Placement and Grading

1.2 REFERENCES

.1 Definitions:
  .1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

.2 Reference Standards:
  .1 Agriculture and Agri-Food Canada (AAFC).
    .1 Plant Hardiness Zones in Canada-2000.
  .2 Canadian Nursery Landscape Association (CNLA)
    .1 Canadian Standards for Nursery Stock-2006.
  .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
    .1 Material Safety Data Sheets (MSDS).

1.3 ADMINISTRATIVE REQUIREMENTS

.1 Scheduling: obtain approval from Departmental Representative of schedule 7 days in advance of shipment of plant material.

.2 Schedule to include:
  .1 Quantity and type of plant material.
  .2 Shipping dates.
  .3 Arrival dates on site.
  .4 Planting Dates.

1.4 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 trees, shrubs, ground cover, fertilizer, mycorrhiza, anti-desiccant, anchoring equipment, and mulch and include product characteristics, performance criteria, physical size, finish and limitations.
  .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

.3 Samples:
  .1 Submit samples of mulch.

1.5 QUALITY ASSURANCE

.1 Qualifications:

.1 Landscape Contractor: to be a Member in Good Standing of Alberta Horticultural Trades Association.
.2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
.3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Ornamental Maintenance designation.

1.6 DELIVERY, STORAGE AND HANDLING

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

.2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
.1 Protect plant material from frost, excessive heat, wind and sun during delivery.
.2 Protect plant material from damage during transportation:
.1 Delivery distance is less than 30 km and vehicle travels at speeds under 80 km/h, tie tarpaulins around plants or over vehicle box.
.2 Delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle where practical.
.3 Protect foliage and root balls using anti-desiccants and tarpaulins, where use of enclosed vehicle is impractical due to size and weight of plant material.

.3 Storage and Handling Requirements:
.1 Immediately store and protect plant material which will not be installed within 1 hour in accordance with supplier's written recommendations and after arrival at site in storage location approved by Departmental Representative.
.2 Protect stored plant material from frost, wind and sun and as follows:
.1 For bare root plant material, preserve moisture around roots by heeling-in or burying roots in topsoil and watering to full depth of root zone.
.2 For pots and containers, maintain moisture level in containers.
.3 For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain moisture level in root zones.

.3 Store and manage hazardous materials in accordance with manufacturer's written instructions.

1.7 WARRANTY

.1 For plant material as itemized on plant list on the drawings the 12 months warranty period is extended to 24 months.

.2 End-of-warranty inspection will be conducted by Departmental Representative.

.3 Departmental Representative reserves the right to extend Contractor's warranty responsibilities for an additional one year if, at end of initial warranty period, leaf development and growth is not sufficient to ensure future survival.

2 Products

2.1 PLANT MATERIAL

.1 Type of root preparation, sizing, grading and quality: comply to Canadian Standards for Nursery Stock.
  .1 Source of plant material: grown in same zone as location of installation, in accordance with Plant Hardiness Zones in Canada.
  .2 Plant material must be planted in zone specified as appropriate for its species.
  .3 Plant material in location appropriate for its species.

.2 Plant material: free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.

.3 Trees: with straight trunks, well and characteristically branched for species.

.4 Bare root stock: nursery grown, in dormant stage, not balled and burlapped or container grown.

.5 Collected stock: maximum 40 mm in caliper, with well developed crowns and characteristically branched; no more than 40% of overall height may be free of branches.
  .1 During collection, ensure 10% maximum seed crop (or plants) are collected from healthy population of many individuals, and from several plants of same species.
  .2 Leave remainder for natural dispersal and as food for dependent organisms.

2.2 WATER

.1 Free of impurities that would inhibit plant growth.

2.3 STAKES

.1 T-bar, steel, 40 x 40 x 5 x 2440 mm.

2.4 WIRE TIGHTENER

.1 Type 1: galvanized steel, rod, triangular shape.

.2 Type 2: turnbuckle, galvanized steel, 9.5 mm diameter with 270 mm open length.

2.5 GUYING WIRE

.1 Type 1: steel, 3 mm wire.

.2 Type 2: 1.5 mm diameter multi-wire steel cable.

.3 Type 3: 3 mm diameter multi-wire steel cable.

2.6 CLAMPS

.1 U-bolt: galvanized, 13 mm diameter, c/w curved retaining bar and hex nuts.

.2 Crimp type.

2.7 ANCHORS

.1 Wood:
  .1 Type 1: 38 x 38 x 460 mm.
  .2 Type 2: 38 x 67 x 600 mm.

.2 Drive-in type.
  .1 Type 1: 13 mm diameter x 75 mm long, aluminum
  .2 Type 2: 18 mm diameter x 120 mm long, aluminum.

.3 Screw-in type:
  .1 Type 1: 100 mm diameter steel disc.

2.8 GUYING COLLAR

.1 Tube: plastic, 13 mm diameter, nylon reinforced.

2.9 TRUNK PROTECTION

.1 Plastic: perforated spiralled strip.

2.10 MULCH

.1 Wood chip: varying in size from 50 mm to 75 mm and 5 to 20 mm thick, free of bark, small branches and leaves.

.2 Stone mulch: stone chip mulch as selected by the Departmental Representative.

.3 Filter cloth: horticultural filter cloth with minimum tensile strength of 500 N and equivalent opening size of 0.05 to 0.105 mm as approved by Departmental Representative.

2.11 FERTILIZER

.1 Synthetic commercial type as recommended by soil test report.
  .1 Ensure new root growth is in contact with mycorrhiza.
  .2 Use mycorrhiza as recommended by manufacturer's written recommendations.

2.12 ANTI-DESICCANT

.1 Wax-like emulsion.

2.13 FLAGGING TAPE

.1 Fluorescent, orange colour.

2.14 SOURCE QUALITY CONTROL

.1 Obtain approval from Departmental Representative of plant material prior to planting.

.2 Imported plant material must be accompanied with necessary permits and import licenses. Conform to Federal, Provincial or Territorial regulations.

3 Execution

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for planting 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 and after receipt of written approval to proceed from Departmental Representative.

3.2 PRE-PLANTING PREPARATION

.1 Proceed only after receipt of written acceptability of plant material from Departmental Representative.

.2 Remove damaged roots and branches from plant material.

.3 Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.

.4 Locate and protect utility lines.

.5 Notify and acquire written acknowledgment from utility authorities before beginning excavation of planting pits for trees and shrubs.

.6 Temporary Erosion and Sedimentation Control: conform to the requirements specified in Section 31 23 33.01

3.3 EXCAVATION AND PREPARATION OF PLANTING BEDS

.1 Establishment of sub-grade for planting beds in accordance with Section 31 22 13 - Rough Grading.

.2 Preparation of planting beds in accordance with Section 32 91 19.13 - Topsoil Placement and Grading.

.3 For individual planting holes:
  .1 Stake out location and obtain approval from Departmental Representative prior to excavating.
  .2 Excavate to depth and width as follows:
    .1 Shrub beds: excavate minimum of 450 mm deep.

.2 Trees and Specimen Shrubs: excavate plant pits large enough for soil ball and 300 mm around and beneath soil ball.

.3 Remove subsoil, rocks, roots, debris and toxic material from excavated material that will be used as planting soil for trees and individual shrubs. Dispose of excess material.

.4 Scarify sides of planting hole.

.5 Remove water which enters excavations prior to planting. Notify Departmental Representative if water source is ground water.

3.4 PLANTING

.1 For bare root stock, place 50 mm backfill soil in bottom of hole.

.1 Plant trees and shrubs with roots placed straight out in hole.

.2 For jute burlapped root balls, cut away top one third of wrapping and wire basket without damaging root ball.

.1 Do not pull burlap or rope from under root ball.

.3 For container stock or root balls in non-degradable wrapping, remove entire container or wrapping without damaging root ball.

.4 Plant vertically in locations as indicated.

.1 Orient plant material to give best appearance in relation to structure, roads and walks.

.5 For trees and shrubs:

.1 Backfill soil in 150 mm lifts.

.1 Tamp each lift to eliminate air pockets.

.2 When two thirds of depth of planting pit has been backfilled, fill remaining space with water.

.3 After water has penetrated into soil, backfill to finish grade.

.2 Form watering saucer as indicated.

.6 For ground covers, backfill soil evenly to finish grade and tamp to eliminate air pockets.

.7 Water plant material thoroughly.

.8 After soil settlement has occurred, fill with soil to finish grade.

3.5 TRUNK PROTECTION

.1 Install trunk protection on deciduous trees as indicated.

.2 Install trunk protection before installation of tree supports.

3.6 TREE SUPPORTS

.1 Install tree supports as indicated.

.2 Use single stake tree support for deciduous trees less than 3 m in height and evergreens less than 2 m in height.
  .1 Place stake on prevailing wind side and 150 mm minimum from trunk.
  .2 Drive stake 150 mm minimum into undisturbed soil beneath roots.
    .1 Ensure stake is secure, vertical and unsplit.
  .3 Install 150 mm long guying collar 1500 mm above grade.
  .4 Thread Type 1 guying wire through guying collar tube.
    .1 Twist wire to form collar and secure firmly to stake. Cut off excess wire.

.3 Use 3 guy wires and anchors for deciduous trees greater than 3 m in height and evergreens greater than 2 m in height.
  .1 Use Type 2 guying wire with clamps for trees less than 75 mm in diameter and Type 3 guying wire with clamps for trees greater than 75 mm in diameter.
  .2 Use Type 1 anchors for trees less than 75 mm in diameter and Type 2 anchors for trees greater than 75 mm in diameter.
  .3 Install guying collars above branch to prevent slipping at approximately 2/3 height for evergreens and 1/2 height for deciduous trees. Collar mounting height not to exceed 2.5 m above grade.
  .4 Guying collars to be of sufficient length to encircle tree plus 50 mm space for trunk clearance. Thread guy wire through collar encircling tree trunk and secure to lead wire by clamp or multi-wraps; cut wire ends close to wrap. Spread lead wires equally proportioned about trunk at 120 degrees.
  .5 Install anchors at equal intervals about tree and away from trunk so guy wire will form 45 degree angle with ground. Install anchor at angle to achieve maximum resistance for guy wire.
  .6 Attach guy wire to anchors. Tension wire and secure by installing clamps.
  .7 Install wire tightener ensuring that guys are secure and leave room for slight movement of tree.
  .8 Saw tops off wooden anchors which extend in excess of 100 mm above grade or as directed by Departmental Representative.
  .9 Install flagging tape to guys as indicated.

.4 After tree supports have been installed, remove broken branches with clean, sharp tools.

3.7 MULCHING

.1 Ensure soil settlement has been corrected prior to mulching.

.2 To watering basin around base of trees, install filter cloth to completely cover basin. Neatly and accurately cut around tree and around edge of watering basin.

.3 Install wood chip mulch and stone chip mulch to a uniform depth of 75 mm.

.4 Spread mulch as indicated.

3.8 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Perform following maintenance operations from time of planting to acceptance by Departmental Representative.

.1 Water to maintain soil moisture conditions for optimum establishment, growth and health of plant material without causing erosion.
  .1 For evergreen plant material, water thoroughly in late fall prior to freeze-up to saturate soil around root system.
  .2 Remove weeds monthly.
  .3 Replace or respread damaged, missing or disturbed mulch.
  .4 For non-mulched areas, cultivate as required to keep top layer of soil friable.
  .5 If required to control insects, fungus and disease, use appropriate control methods in accordance with Federal, Provincial and Municipal regulations. Obtain product approval from Departmental Representative prior to application.
  .6 Remove dead or broken branches from plant material.
  .7 Keep trunk protection and guy wires in proper repair and adjustment.
  .8 Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.

3.9 MAINTENANCE DURING WARRANTY PERIOD

.1 From time of acceptance by Departmental Representative to end of warranty period, perform following maintenance operations.
  .1 Water to maintain soil moisture conditions for optimum growth and health of plant material without causing erosion.
  .2 Reform damaged watering saucers.
  .3 Remove weeds monthly.
  .4 Replace or respread damaged, missing or disturbed mulch.
  .5 For non-mulched areas, cultivate monthly to keep top layer of soil friable.
  .6 If required to control insects, fungus and disease, use appropriate control methods in accordance with Federal, Provincial and Municipal regulations. Obtain product approval from Departmental Representative prior to application.
  .7 Apply fertilizer in early spring as indicated by soil test.
  .8 Remove dead, broken or hazardous branches from plant material.
  .9 Keep trunk protection and tree supports in proper repair and adjustment.
  .10 Remove trunk protection, tree supports and level watering saucers at end of warranty period.
  .11 Remove and replace dead plants and plants not in healthy growing condition. Make replacements in same manner as specified for original plantings.
  .12 Submit monthly written reports to Departmental Representative identifying:
    .1 Maintenance work carried out.
    .2 Development and condition of plant material.
    .3 Preventative or corrective measures required which are outside Contractor's responsibility.

3.10 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  .1 Leave Work area clean at end of each day.

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

3.11 CLOSEOUT ACTIVITIES

.1 Submit maintenance reports for trees, shrubs, and other plantings.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for sewer manholes, catch basins and other structures for storm and sanitary sewers.

1.2 RELATED WORK

.1 Excavations for sewer manholes and catch basins - Trenching Section 31 23 16.

.2 Gravity sewers - Section 33 19 00

1.3 MATERIALS TESTING

.1 One hundred per cent of the manhole barrels and tee riser sections using confined O-Ring joints shall be vacuum tested in the plant at the Contractor's expense.

.2 The vacuum test shall consist of 300 mm of mercury vacuum which shall be allowed to stabilize and then be held for 20 seconds with no more than 2.5% pressure loss.

.3 Sections not passing the vacuum test shall not be used. Sections passing the test shall be marked - "Air Tested".

1.4 STANDARDS

.1 Materials supplied in this section are in accordance with ASTM, and CGSB Standards.

.2 Where conflicts in specifications arise the local Standard Specifications for Sewer Constructions shall be considered the minimum acceptable standard.

1.5 SHOP DRAWINGS

.1 Submit shop drawings for all cast in place reinforced concrete structures, for tee - riser manholes and miscellaneous metals.

1.6 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 Quality Control.

.2 Submit to the Engineer a list of sources of materials including gravel, borrow materials, and concrete.

.3 Provide samples, test results, sieve analyses and reports for preliminary approval of materials.

1.7 QUALITY CONTROL TESTING

.1 Refer to Section 01 45 00 Quality Control.

.2 Moisture density curves to ASTM D698-78.

.3 Sieve analyses to ASTM C136-84a.

.4 Filed densities to ASTM D2167-84 or to ASTM D2922-81.

.5 Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number required.

.6 Provide moisture/density curves for each type of material from each source of material to be compacted to a specified density.

.7 Field densities:

 .1 Crushed gravel - one for each 2000 m^2 of compacted layers.

 .2 Backfill at Manholes, Catch Basins - one for each manhole or catch basin.

 .3 Bedding and Backfill of catch basin leads - one for each 100 metres of pipe.

PART 2 - PRODUCTS

2.1 CONCRETE

.1 Concrete shall be made with type 50 sulphate resistant cement.

.2 Maximum slump 75 mm, Class 25 MPa.

.3 In freezing weather, provide concrete with a temperature of not less than 10°C, and maintain this temperature for 72 hours.

.4 For reinforced concrete structures refer to Division 3 Concrete.

2.2 MORTAR

.1 Mortar shall conform to the following mix:

.1 1 part cement, type 50 sulphate resistant

.2 1½ parts clean sharp sand

.3 water to provide workability

.2 In freezing weather, heat sand, and cement and apply mortar warm. Protect joints from freezing until mortar has set.

.3 Grout to be non shrink type Master Builders Embeco or approved equivalent alternative.

2.3 CRUSHED GRAVEL

.1 Crushed gravel shall be maximum size 25 mm, clean crushed material conforming with the following gradation.

Sieve Size	Percent Passing
20 mm	100
12.5 mm	60 - 96
5.0 mm	37 - 76
2.0 mm	26 - 60
400 micro-m	11 - 41
160 micro-m	6 - 21
63 micro-m	2 - 10

2.4 BRICKS

.1 Concrete bricks conforming to ASTM C55-85 Type 1 grade U-l.

2.5 SAFETY STEPS

.1 Fabricate from 19 mm diameter steel and hot-dip galvanize after fabrication or use 20 mm aluminum manhole steps with minimum load resistance of 300 kg.

2.6 WATERPROOFING/DAMP-PROOFING

.1 Exterior damp-proofing - cement mortar coating - 15 mm thickness.

.2 Exterior damp-proofing - 2 coat brushed on bituminous compound conforming to CGSB-37-GP-6Ma.

.3 Exterior Waterproofing - Vandex Super - 0.8 kg per m^2 and Vandex Premix - 0.8 kg per m^2.

2.7 SAFETY PLATFORMS

.1 Construct as detailed on the drawings or use platforms as supplied by M.S.U. Daymond. Submit shop drawings for the Engineers review.

2.8 MANHOLE BASES - TEE RISER TYPE

.1 Precast tee sections may be used for manholes where pipes pass straight though manholes.

.2 Tee risers to ASTM C478M-85a, equivalent in strength to the highest class or highest D-load pipe to which it is connected.

.3 Use Type 50 sulphate resistant cement; confined O-Ring joints and concentric reinforcing.

.4 Submit shop drawings.

2.9 MANHOLE BASES

.1 Poured-in-place concrete as detailed or precast to ASTM C478M-85a.

2.10 MANHOLE BARRELS AND TOPS

.1 Barrels - circular precast sections to ASTM C478M-85a with confined O-Ring joints.

.2 Cast-in-Place Concrete - as detailed on drawings.

.3 Top Sections - cast-in-place or precast to withstand AASHTO - H20 loading, as detailed on drawings. Top sections shall be flat top where depth to top of pipe is less than 2.0 m or where shown on drawings. Top section shall be precast conical, eccentric in accordance with ASTM C478M-85a, in other locations.

.4 Covers, Frames cast iron with vent holes, capable of withstanding AASHTO - H20 loading, or without vent holes for buried covers, - Norwood F39 or NF80.

.5 Safety Steps - cast into precast section with maximum spacing 300 mm.

.6 Joints - joints to be confined O-Ring type. Use sealing compound between precast concrete and cast-in-place concrete and between grade rings.

.7 Precast - all precast units to conform with ASTM C478M-85a.

2.11 CATCH BASINS

.1 Catch basin manholes - conform to ASTM C478M-85a with precast flat tops to withstand AASHTO - H20 loading or precast conical tops. Where depth to top of pipe is less than 2.0 m, use flat tops.

.2 Catch basin barrels -

.1 Type 1 - 900 mm I.D. ASTM C478M-85a barrel with 100 mm precast base and precast slab top. Safety steps are to be installed in all catch basins.

.3 Frame and Cover -

.1 Type 1 Standard frame, grate and side inlet for use with Type 1 barrel Norwood F51.

.2 Type 1 Standard frame, grate and side inlet for rolled curb and gutter, for use with Type 1 barrel - Trojan K2.

.3 Type 2 Standard Side Inlet for rolled curb and gutter - Norwood F33, K7.

.4 MH - Standard top Inlet - Norwood F39 or F38.

.4 Catch Basin Manhole, Type 1 Barrel - Mortar joints.

2.12 DROP STRUCTURES

.1 For pipes in drop structures use materials in accordance with sewermain pipe.

.2 Use all other materials as detailed on the drawings.

2.13 MISCELLANEOUS METALS

.1 All miscellaneous metal used inside sewer manholes, or buried as part of sewer manholes shall be steel, hot dipped galvanized after fabrication.

.2 All inserts and insert bolts shall be stainless steel.

2.14 FROST COVERS

.1 Insulation shall be 50 mm thick rigid styrofoam insulation with FRP fiberglass coating, both sides.

.2 Handles and supports shall be aluminum.

PART 3 - EXECUTION

3.1 GENERAL

.1 Excavation for manholes and catch basins shall be as specified for Trenching Section 31 23 16.

.2 Remove water from excavations prior to placing base concrete.

.3 Over excavate the base if the material at the bottom of the trench is unsuitable for support, and replace with crushed gravel compacted in 150 mm lifts to 95% Standard Proctor Density.

.4 Bases for structure shall be poured on solid, unfrozen ground.

.5 Provide concrete as specified and protect poured concrete to maintain temperature of a least 10°C for the first 72 hours.

.6 Granular bases, where specified, shall be placed on solid unfrozen ground in 150 mm lifts and compacted to 95% Standard Proctor Density.

.7 Bases shall be set level so that manhole and catch basin barrels can be set plumb.

3.2 MANHOLE CONSTRUCTION

.1 Manholes, bases and vaults shall be constructed in accordance with details on the drawings.

.2 Set bottom sections plumb on poured or precast bases and fill around with mortar.

.3 Install flexible sealing compound and set manhole sections in place, in accordance with the direction of the manufacturer of the sealing compound.

.4 Manhole rungs shall be aligned, maximum spacing 300 mm.

.5 Safety platforms shall be installed so that the vertical distance from top or bottom of manhole to platform or vertical distance between platforms does not exceed 6.0 m, or less to conform with safety regulations.

.6 Cover all joints, interior and exterior with mortar.

.7 Waterproof or damp proof the exterior if ordered by the Engineer.

.8 Build pipes and stubs into manholes and form smooth flow channels.

.9 For sanitary manholes, all joints shall be sealed with rubber gaskets and grouted inside and outside.

3.3 MANHOLE BENCHING

.1 Benching of flow channels shall be in accordance with details on the drawings.

.2 Use form work to install channels and benching, and finish the flow channel using a steel trowel.

3.4 MANHOLE COMPLETION

.1 Construct manholes as close behind pipe laying as practical; and no further than 600 m behind any pipe laying crew.

.2 Compact backfill around manholes using mechanical tampers, the full depth of the manhole. Compaction shall be to a minimum of 98% of the maximum density as determined by the Standard Proctor Compaction Test. Compacted backfill is required around manholes regardless of the class of backfill for the pipe.

.3 Unless otherwise specified, set the conical tops such that the vertical side is on the right hand side of the manhole, when looking upstream.

.4 Adjust tops to finished grades.

.5 For all manholes located within the road carriageway, an area 0.6 m wide from the bottom of the cone to the subgrade elevation of the roadway shall be backfilled with fillcrete or insulcrete.

3.5 CATCH BASIN CONSTRUCTION

.1 Set the precast base level, and place the barrel, vertically on the base.

.2 Fill around the bottom of the barrel, inside and outside with the cement mortar.

.3 Place catch basin lead pipe in place and grout in place.

.4 Set top rings, adjust to grade and set frame. Rings and frame shall be set in mortar.

.5 Backfill to the finished grade with granular material placed in 150 mm lifts compacted to a minimum of 98% of the maximum density as determined by the Standard Proctor Compaction Test.

3.6 CATCH BASIN LEADS

.1 Lay leads in accordance with the specification for sewermain, using class B(sand) bedding.

3.7 CLEANUP

.1 Remove dirt, mortar, debris and other material from manholes and catch basins.

.2 Clean manhole rungs.

.3 Place covers after cleaning.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for underground piping at structures.

.2 Included are pressure pipes, gravity sanitary sewers, gravity storm sewers, forcemains and appurtenances.

1.2 RELATED WORK

.1 Excavation and trenching for underground pipe is specified in Section 31 23 33 - Excavation and Site Work.

.2 Welding of steel pipe is specified in Division 11 - Process Mechanical.

1.3 REFERENCE STANDARDS

.1 Standards of Alberta Environment, Standards and Approvals Division apply to the work of this section.

.2 Refer to AWWA standards with regard to watermain, fittings, valves and hydrants.

.3 Refer to CSA and ASTM Standards for various sewer, drainage and water materials.

1.4 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 Quality Control.

.2 Submit to the Engineer for review:

  .1 Sieve analysis of bedding sand

1.5 QUALITY CONTROL TESTING

.1 Refer to Section 01 45 00 - Quality Control.

.2 Moisture density curves: to ASTM-D698.

.3 Sieve analyses: to ASTM-C136.

.4 Field densities: to ASTM-D2167 or to ASTM-D2922.

.5 Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number required.

.6 Field densities

.1 Pipe Bedding - one for each 100 metres of pipe installed

.2 Pipe Zone Backfill - one for each 100 metres of pipe installed

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

.1 Unload and store materials at the site so that they are not damaged and are kept clean.

.2 Store materials in accordance with the manufacturer's recommendations.

1.7 REGULATIONS

.1 Regulations of Alberta Labour, Occupational Health and Safety Act apply to the work of this section.

PART 2 - PRODUCTS

2.1 CONCRETE

.1 In accordance with Section 03 30 00 - Cast-In-Place Concrete.

2.2 PRESSURE PIPE

.1 Asbestos Cement

.1 To AWWA-C400.

.2 Class -

.3 Size -

.2 Ductile Iron

.1 To AWWA-C151/A21.51.

.2 Thickness Class -

.3 Size -

.4 Cement mortar lining.

.5 Hyprotec coating.

.3 Polyvinyl Chloride

.1 To AWWA-C900, with rubber gasket joints.

.2 Rating -

.3 Size -

.4 Polyethylene

.1 To CSA-B137.1.

.2 Pressure Rating -

.3 Size -

.5 Concrete Pressure Pipe

.1 To AWWA-C301.

.2 Joints -

.3 Pressure Rating -

.4 Sulphate Resistant Cement -

.5 Size -

.6 Steel Pipe

.1 To AWWA-C200.

.2 Wall thickness -

.3 Size -

.4 Ends prepared for welding.

.5 Lining -

.6 Coating -

.7 Glass Fiber - Reinforced Pipe

.1 To AWWA-C950 and ASTM-D3754.

.2 Pressure Rating -

.3 Size -

.4 Joint Type -

2.3 FITTINGS, VALVES, HYDRANTS

.1 Fittings for Asbestos Cement - AWWA-C110/A21.10.

.2 Fittings for Ductile Iron - AWWA-C110/A21.10.

.3 Fittings for P.V.C. - AWWA-C110/A21.10.

.4 Fittings for P.E. - ASTM-D1248.

.5 Fittings for Steel - ASTM-A234M.

.6 Fittings for Glass - Fiber - Reinforced Pipe.

.7 Couplings - Dresser - A1-clad, coated, Style 38.

.8 Victaulic - Style 71.

.9 Flanges - ASTM-A181, Grade 1.

.10 Bolts and Nuts - ASTM-A307 galvanized.

.11 Gate Valves - AWWA-C500.

.12 Butterfly Valves - AWWA-C504.

.13 Hydrant - AWWA-C502.

GRAVITY DRAIN PIPE

.14 PVC

.1 To CSA-B182.1.

.2 SDR 35 -

.3 Joint Type -

.4 Size –

.15 Non-Reinforced Concrete

.1 ASTM-C14.

.2 Type of Joint -

.3 Type of Cement -

.4 Size -

.16 Reinforced Concrete

.1 ASTM-C76 or C655.

.2 Pipe Class or D load -

.3 Type of Joint -

.4 Size -

.17 Glass - Fiber - Reinforced Pipe

.1 AWWA-C950 and ASTM-D3754.

.2 Pipe Class -

.3 Type of Joint -

.4 Size -

.18 Vitrified Clay Pipe

.1 CSA-A60.1.

.2 Extra strength, non pressure.

.3 Pipe joints to CSA-A60.3.

.4 Type of Joint –

.19 Ultra-Rib PVC

.1 CSA –

.2 Type of Joint –

.3 Size -

2.4 MANHOLES, CATCH BASINS

.1 ASTM-C478.

.2 Barrel Size -

.3 Manhole frame and cover - Norwood NF-80.

.4 Catch Basin Frame and Cover - Norwood.

.5 Joints - Kent-seal or equal, or use O-ring barrels.

2.5 BEDDING SAND

.1 Comply with the following gradation:

Sieve Size	Percent Passing
9.5 mm 100	
4.75 mm	90 - 100
150 micro-m	20 max.

.2 The same bedding sand specification applies to sewermain and to pressure pipe.

.3 Use bedding sand for backfill in the pipe zone.

PART 3 - EXECUTION

3.1 TRENCH INSPECTION

.1 Inspect the trench for clearance, grade and foundation for pipe.

3.2 ALIGNMENT AND GRADE

.1 Lay pipes to the alignment and grade shown on the drawings.

.2 Grades of sewer lines shall not deviate from design grades by more than 6 mm plus 10 mm per m of diameter of the sewer pipe.

3.3 BEDDING

.1 Prepare bedding; placing 100 mm of sand compacted to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

.2 Where the drawings show that Class A concrete bedding is required, supply and place 20 MPa concrete the full width of the trench to the depth shown on the drawings.

3.4 BACKFILLING IN THE PIPE ZONE

.1 Backfill all pipes using bedding sand compacted to 95% of the maximum density as determined by the Standard Proctor Compaction Test to 300 mm over the pipe. The backfill shall be placed the full width of the trench.

.2 Do not use frozen materials.

3.5 PIPE LAYING AND JOINTING

.1 Lay pipes so that there is a smooth, uniform invert.

.2 Lay pipes so that each pipe is supported uniformly and continuously throughout its length.

.3 Clean pipe ends and make joints in accordance with the manufacturer's recommendations.

.4 Watermain joints shall be in accordance with AWWA Standards and Manuals where applicable. Welded joints in steel pipe shall be made in accordance with welding specifications in Division 11. Joints in sewermain shall be accordance with manufacturer's recommendations.

.5 Maintain the continuity of corrosion resistant linings on pipes. Field welds on cement mortar lined steel pipe shall be made in accordance with procedures recommended by the lining supplier. Field welds on epoxy or other material lined pipes shall be touched up after welded; and cured in accordance with the lining supplier's recommendations.

.6 Maintain the continuity of corrosion resistant external coatings on steel or ductile iron pipe. All coatings shall be checked with a holiday detector and repairs made with polyethylene tape, hand wrapped. Joints shall be wrapped or heat shrink sleeves shall be applied.

3.6 FITTINGS, VALVES, HYDRANTS

.1 Install fittings, valves and hydrants in accordance with details and in the locations shown on the drawings.

.2 Set valves and hydrants plumb and to finished grades.

.3 Construct reaction blocks from 20 MPa concrete at each fitting and hydrant; and where shown on the drawings.

.4 Coatings and linings shall be repaired to match pipe linings and coatings. Couplings and other fittings shall be filled with Denso plast and coated with Denso Tape.

3.7 MANHOLES, CATCH BASINS

.1 Install manholes, catch basins and sewer structures as shown on the drawings.

.2 Cast-in-place concrete shall be sulphate resistant 25 MPa placed in accordance with specification for Cast-In-Place Concrete - Section 03 30 00.

.3 Set frames and covers to finished grades.

.4 Form smooth flow channels inside structures and make all joints watertight.

3.8 CLEANING

.1 Provide all water, air or other materials to clean and flush underground pipes.

.2 Chlorinate watermains in accordance with AWWA-C651.

3.9 TESTING

.1 Sewermain shall be inspected visually by the Engineer to determine alignment, breaks or obstructions.

.2 If ordered by the Engineer, perform a T.V. camera test of all sewermains in place. Refer to Section 33 01 30 – Television Inspection.

.3 Perform a leakage test on all pressure pipe. Test pressure shall be the pressure rating of the pipe for a duration of 2 hours.

.4 Allowable leakages:

.5 Steel pipe - no leakage

.6 All other pipe - in accordance with the formula:

$$L = \frac{NDP}{128,300}$$

where

L = allowable leakage, litres

N = number of pipe joints

D = nominal diameter

P = square root of test pressure - kPa

.7 Repair and retest until test results are acceptable.

3.10 CONNECTION TO EXISTING SYSTEM

.1 Take care to prevent debris, sand or other material from entering an existing sewer system.

.2 Make connection to an existing water system in such a manner that interruption of service is minimal and chlorination and flushing are carefully and thoroughly carried out.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for pressure pipe for watermains, water supply mains and sewage forcemains.

.2 The work includes:

.1 Supply of pipe and jointing materials

.2 Supply of fittings, valves and hydrants

.3 Installation, disinfection and testing

1.2 RELATED WORK

.1 Trenching - Section 31 23 16.

1.3 QUALITY ASSURANCE

.1 Materials supplied in this section are in accordance with AWWA, ASTM and CSA standards.

.2 The Engineer may at any time require the Contractor to produce certification by an independent testing agency that materials used conform to the specified standards, and the costs of such certifications shall be borne by the Contractor.

.3 Testing laboratories or agencies to test materials shall be independent testing agencies approved by the Engineer.

.4 Hydrostatic testing is specified in Part 3 Execution.

1.4 SUBMITTALS

.1 Submit shop drawings for concrete pressure pipe and fittings.

.2 Submit shop drawings in accordance with Section 01 33 23.

.3 Provide operation and maintenance data for valves. Data shall be in accordance with Section 01 33 23.

PRODUCT DELIVERY, STORAGE AND HANDLING

.4 Pipe and accessory materials shall be unloaded and stored at the site by the Contractor, with care to prevent damage.

.5 Store materials so that they are kept clean.

.6 Drain valves and hydrants to eliminate damage due to freezing of trapped water.

.7 Store pipe in accordance with the manufacturer's recommendations.

1.5 REGULATIONS

.1 The Standards and Guidelines for Municipal Water Supply, shall also apply to the work in this section.

1.6 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 Quality Control.

.2 Submit to the Engineer a list of sources of materials including bedding materials, backfill materials and concrete.

.3 Provide samples, test results, sieve analyses and reports for preliminary approval of materials.

1.7 QUALITY CONTROL TESTING

.1 Refer to Section 01 45 00 Quality Control.

.2 Moisture density curves: to ASTM D698-78.

.3 Sieve analyses: to ASTM C136-84a.

.4 Field densities: to ASTM D2167-84 or to ASTM D2922-81.

.5 Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number required.

.6 Provide moisture/density curves for each type of material from each source of material to be compacted to a specified density.

.7 Field densities:

- .1 Pit run gravel - one for each 2000 m^2 of compacted layers.
- .2 Pipe Bedding - one for each 100 m of pipe installed.
- .3 Pipe Zone Backfill - one for each 100 m of pipe installed.

PRODUCTS

1.8 PIPE

.1 Ductile Iron Pipe - ANSI/AWWA C151/89

.1 Flanged joint - ANSI/AWWA C115/A21.15-83

.2 Mechanical joint - ANSI/AWWA C111/90

.3 Rubber Gasket* - ANSI/AWWA C111/A21.11-80

.4 Lining - Cement Mortar - ANSI/AWWA C104/A21.4-85

.5 Conductivity Strip - Conductoflex

.6 Coating is 0.4 mm of mastic sealant evenly over pipe in conformity to shaw pipe protection specification #5 plus 1.0 mm of high density polyethylene “yellow jacket”.

* Nitrile gaskets shall be used in areas contaminated with organic compounds.

.2 Concrete Pressure Pipe - AWWA C301-84

.1 Hyprescon Bell and Spigot joint

.2 Hyprescon Bell Bolt joint

.3 Hyprescon Flanged Ends - ANSI/AWWA C207-86

.4 Hyprescon Plain Steel-Ends

.5 Sulphate Resistant Cement

.3 Polyvinyl Chloride (PVC) manufactured to ANSI/AWWA C900-89 and certified to CSA 313 B137.3 M86 (pipe sizes 100 mm to 300 mm).**

.1 Rubber gasket joints ASTM Spec. D3139-84

.2 Materials - Type 1 Grade 1 ASTM Spec. D1784-81

.3 Class Designation 12454A or 12454B

.4 Pressure Rating 1035 kPa DR18

.5 Designated for potable water use.

.4 Polyvinyl Chloride (PVC) manufactured to ANSI/AWWA C905-88 and certified to CSA B137.3 M86 (pipe sizes 400 mm - 500 mm).**

.1 Materials to ASTM D1784-81 (PVC 1120)

.2 Suitable for potable water

.3 Rubber gasket - Plas-Tyton joints or approved equivalent alternative

.4 SDR

.5 Designated for potable water use.

** PVC not to be used in areas which are or could be contaminated with organic compounds.

1.9 FITTINGS

.1 Concrete Pressure Pipe

.1 Hyprescon, to match pipe class

.2 Ductile Iron

.1 Cast iron rubber gasket type - ANSI/AWWA C110/93 C111-90

.2 Cast iron mechanical joint - ANSI/AWWA C110/A21.10-87

.3 Flanged joint - ASME/ANSI B16.1 Class 125

.4 Lining for fittings - ANSI/AWWA C104/A21.4-85

.5 Coating equal to pipe or as approved by the engineer

.3 PVC

.1 Cast iron rubber gasket type - ANSI/AWWA C110/A21.10-87

.2 Class 150 PVC fittings conforming to AWWA C900-89 and certified under CSA B137.2 M93, pressure rating to match pipe.

1.10 VALVES

.1 Gate Valves - ANSI/AWWA C500-93

.1 1380 kPa cold water service for valves 300 mm and smaller (200 psi)

.2 1,030 kPa cold water service for valves 400 mm and larger (150 psi)

.3 Nonrising, stem - 50 mm square operating nut

.4 Bronze mounted, solid wedge or double disc type

.5 Valve connections to match the type of pipe

.6 Turns to open - clockwise

.2 Butterfly Valves - ANSI/AWWA C504-87

.1 Wafer type - to 500 diameter

.2 Short body flanged - to 1800 diameter

.3 Class 150B

.4 Cast Iron Body - ASTM A126-84

.5 Seat - Buna S rubber

.6 One piece steel shaft

.7 O-ring shaft seals

.8 Corrosion resistant seat

.9 Cast iron disc

.10 Valve body and disc epoxy coated

.11 Sealed, lubricated gear operator

.12 Operator-full class 150B seating

.13 Open clockwise with 50 mm square operating nut

.3 Valve Box and Extension

.1 Adjustable to 3.3 m of bury

.2 Screw type or sliding type

.3 Cast iron - asphaltic or epoxy coated

.4 Extension stem 25 mm square mild steel with 50 mm square operating nut and flange

.5 Screw type (Type B) shall be used for all valves located in sidewalks or roadways

1.11 COUPLINGS - PLAIN AND TRANSITION

.1 Rings and end plates - enamel coated ductile iron or nylon coated steel

.2 Rubber gaskets

.3 Chrome plated or corrosion resistant alloy bolts

.4 Dresser, Robar or approved equivalent alternative

1.12 HYDRANTS

.1 ANSI/AWWA C502-85, ULC, UL or FM approved

.2 Dry barrel compression type closing with pressure

.3 Iron body, bronze mounted with O-ring seals at operating nut

.4 Minimum opening 115 m diameter

.5 Barrel O.D. - 150 mm minimum

.6 Depth of trench 2.9 m

.7 One 146 mm pumper nozzle and two 63.5 mm hose connections to conform with threads and sizes on existing hydrants in the Municipality's system

.8 Flanged at ground line with 150 mm bottom inlet connection to match the type of watermain

.9 Bottom connection with drip valve and drain

.10 Operating nut - three sided or to match existing hydrants in the Owner's system

.11 Storts fittings required on the steamer ports

.12 Turn to open - Counterclockwise

.13 Barrel to be fluorescent yellow equal to CIL #3486 Valspar Z0G-684

.14 Pumper and nozzle caps to be painted black

1.13 CONCRETE

.1 Compressive strength 25 MPa at 28 days sulphate resistant Class 50 - CAN3-A23.1-M77.

1.14 PIPE BEDDING

.1 Sand, complying with the following gradation.

Sieve Size	Percent Passing
9.5 mm	100
4.75 mm	90 - 100
150 micro-m	20 max.

.2 Gravel, complying with the following gradation.

Sieve Size	Percent Passing
20 mm	100
12.5 mm	60- 96
5.0 mm	37 - 76
2.0 mm	26 - 60
400 micro-m	11 - 41
160 micro-m	6 - 21
63 micro-m	2 - 10

BACKFILL IN THE PIPE ZONE

.3 Sand complying with the following gradation.

Sieve Size	Percent Passing
9.5 mm	100
4.75 mm	90 - 100
150 micro-m	20 max.

.4 Selected native soil shall be material selected from the excavated trench materials by the Contractor. Selected native soil shall be well graded and shall not contain particles larger than 25 mm. It shall be free of frozen material and shall not contain organic material in quantities that may harm the installation.

PART 2 - EXECUTION

2.1 UNLOADING, STORING, HAULING, STRINGING

.1 Unloading, stockpiling, loading, hauling and stringing shall be done in such a manner as to prevent damage to pipe, lining, coating, fittings, valves, hydrants and other materials.

.2 Use only equipment approved by the Engineer.

.3 Where necessary, protect material from exposure by sunlight, or from any condition that may harm pipe, linings or coatings. Handle PVC pipe in cold weather in accordance with the manufacturer's recommendations.

.4 String pipe without interfering with access for construction operations, landowner and tenants.

2.2 TRENCH INSPECTION

.1 Check trench bottom for stability and notify the Engineer.

.2 Remove unstable soil and replace with compacted pit run gravel, or washed rock if ordered by the Engineer in writing.

2.3 INSPECTION OF PIPE AND ACCESSORIES

.1 Inspect for defects immediately before lowering into the trench.

.2 Clean pipes, fittings, valves before installation.

2.4 ALIGNMENT AND GRADE

.1 Lay pipe to the required alignment and grade, with fittings, valves, hydrants and all other appurtenances at their required locations.

.2 Provide 2.75 m minimum depth of cover on the pipe.

.3 Erect batter boards or sight rails over the trench at intervals of not more than 30 m to provide control, or provide control by laser beam in a manner approved by the Engineer.

.4 Acceptable tolerances are as follows:

  .1 Alignment - the centerline of the pipe shall not be more than 150 mm off the given line.

  .2 Elevation - the pipe invert shall not be more than 50 mm off the given elevation.

.5 No deviation shall be made from the required line or grade without the written consent of the Engineer.

2.5 TRENCH WIDTHS

.1 Widths of trenches shall be such that pipes can be laid and jointly properly and backfill placed and compacted properly.

.2 Trench walls shall be vertical to 300 mm above the top of the pipe and the width at this location shall not exceed the maximum.

.3 Trench Width - Single Pipe

  .1 Minimum - nominal pipe diameter plus 400 mm

  .2 Maximum - nominal pipe diameter plus 600 mm

.4 Trench Width - More than 1 Pipe

  .1 Minimum and maximum - in accordance with drawings.

2.6 PIPE BEDDING

.1 Prepare the pipe bedding in accordance with the drawings and the following specifications.

.2 Class A - concrete bedding placed the full width of the trench to the depth shown on the drawings.

.3 Class B - Sand or approved gravel bedding material placed the full width of the trench and compacted to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

.4 Class C - removal of rocks and debris from the trench bottom and shaping the trench bottom to provide support throughout the length of the pipe.

.5 Provide bell or coupling holes and support the pipe uniformly and continuously throughout its length.

2.7 BACKFILLING IN THE PIPE ZONE

.1 The pipe zone is defined as that part of the trench from the pipe bedding to 300 mm above the top of the pipe, or above the top of the highest pipe in a combined trench.

.2 Backfilling in the pipe zone shall be in accordance with the drawings and the following specifications.

.3 Class A - backfill with sand above the concrete bedding, uniformly placing layers of sand in the trench, at both sides of the pipe for the full width of the trench. Compact in layers to a minimum of 95% of the maximum density as determined by the Standard Proctor Compaction Test until the compacted sand is 300 mm over the top of the pipe. Compact under and around pipe joints.

.4 Class B - Backfill with sand or selected granular material deposited uniformly in the trench at both sides of the pipe for the full width of the trench. Compact in layers to a minimum of 95% of the maximum density as determined by the Standard Proctor Compaction Test, until the compacted backfill is 300 mm above the top of the pipe. Compact under and around pipe joints.

.5 Class C - backfill with sand or selected native soil deposited uniformly in the trench at both sides of the pipe for the full width of the trench. Compact in layers to a minimum of 95% of the maximum density as determined by the Standard Proctor Compaction Test, until the compacted backfill is 300 mm above the top of the pipe. Feedermains to be same as Class B with selected granular material placed and compacted to the pipe spring lines. Distribution mains to be bedded on insitu material pre-shaped to one-half of the pipe diameter of the pipe base.

2.8 LOWERING PIPE AND ACCESSORIES INTO TRENCH

.1 Use implements, tools and facilities satisfactory to the Engineer, and use care to prevent damage to pipe and material. Do not drop pipe or materials into the trench.

.2 Cover pipe ends if necessary to keep clean.

2.9 PIPELAYING - GENERAL

.1 Lay pipes with the bell ends facing in the direction of the laying operations.

.2 Cut pipes where necessary to install fittings and valves. Make cuts in accordance with the manufacturer's recommendations using recommended cutting tools and cut pipes squarely and accurately.

.3 Pipe deflections at joint shall not exceed those specified by the pipe manufacturer.

.4 Do not lay pipe in water or when, in the opinion of the Engineer, trench conditions are unsuitable.

.5 Cover open ends of installed pipe when piping laying is not in progress to keep out trench water.

.6 Heat gaskets as necessary for pipe laying in cold weather conditions.

2.10 LAYING DUCTILE IRON PIPE WITH RUBBER GASKET JOINTS

.1 Clean pipe and remove excess coal tar from pipe ends.

.2 Centre the pipe ends in the trench.

.3 Insert the gasket in the groove of the bell end.

.4 Apply a film of lubricant by brush or hand.

.5 Push the spigot end into place, to the mark on the pipe.

.6 Connect the electrical conductance device.

.7 Make pipe joints in accordance with the manufacturer's recommendations.

.8 The AWWA Standard for the Installation of Cast Iron Watermains ANSI/AWWA C600-87 shall apply to the work of this section.

2.11 LAYING DUCTILE IRON PIPE WITH MECHANICAL JOINTS

.1 Clean pipe and remove excess coal tar from pipe ends.

.2 Apply a solution of soapy water to pipe ends and place gland ring and the gasket over the spigot end.

.3 Place the spigot end into the socket and centre the pipe.

.4 Place backfill around the pipes to maintain positions.

.5 Tap the gland ring into place, set bolts all around and tighten finger tight.

.6 Tighten bolts with a torque wrench to the following ranges:

16 mm	54 - 80 Joules
19 mm	80 - 120 Joules
25 mm	95 - 135 Joules
32 mm	120 - 165 Joules

.7 Make pipe joints in accordance with the manufacturers' recommendation.

.8 The AWWA Standard for the Installation of Cast Iron Watermains ANSI/AWWA C600-87 shall apply to this section.

2.12 LAYING CONCRETE PRESSURE PIPE

.1 Clean the ends of the pipes and the gasket.

.2 Apply a thin layer of an approved lubricant to the face of the bell, the gasket groove of the spigot and the gasket.

.3 Position the gasket in the groove and equalize the stretch of the gasket around the circumference of the pipe.

.4 Centre the pipe and make the joint with a straight in pull using come alongs or powered winches.

.5 Provide correct joint space in accordance with the manufacturer's recommendations.

.6 Check the completed joint with a feeler gauge to determine if the gasket is properly sealed in the groove.

.7 Point the joint space with mortar.

.8 Grout the exterior joint space using a wrapper held in place with bands.

.9 Coat the exposed surfaces of steel with approved coating material, applied in accordance with the manufacturer's recommendations.

.10 Make all pipe joints in accordance with the manufacturer's recommendations and in accordance with the installation procedures outlined in AWWA Manual No. M9 - Concrete Pressure Pipe.

2.13 LAYING PVC PIPE

.1 Clean the bell end, and the spigot ends of the pipes.

.2 Insert the rubber ring with care so that the ring is in the correct position and is seated evenly around the pipe.

.3 Do not lubricate the rubber ring.

.4 Lubricate the spigot end, covering the beveled end and the entire circumference of the pipe, using a brush, cloth, hand, sponge or glove.

.5 Insert the spigot end into the bell so that it is in contact with the ring. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell, using a bar and a block, or other approved equipment.

.6 Cut pipes with a fine tooth hack saw to make a square cut and bevel the ends using a beveling tool. Locate the reference mark the proper distance from the bevel end.

.7 Lay PVC pipe in accordance with the recommendations of the manufacturer of the pipe.

2.14 LENGTH OF PIPE AT FITTINGS AND RIGID STRUCTURES

.1 Use 1000 mm maximum pipe lengths where 200 mm or smaller diameter rigid watermains connect to valves, hydrants or structures.

.2 Use 1000 mm maximum pipe lengths where 200 mm or smaller diameter asbestos - cement watermains connect to fittings.

.3 Use 2000 mm maximum pipe lengths where 250 mm or larger diameter rigid watermains connect to valves, hydrants or structures - applies to all pipe materials.

.4 Use 2000 mm maximum pipe lengths where 250 mm or larger diameter asbestos cement watermains connect to fittings.

.5 At least one flexible joint shall be used between two adjacent rigid joints.

2.15 JOINTING PIPE TO FITTINGS

.1 Connect pipes to fittings using rubber gasket or mechanical joints.

.2 Where dissimilar pipes are connected or where rubber gasket or mechanical joints cannot be made to connect use sleeve type couplings or flanged connections.

.3 Where plastic pipe is connected to butterfly valves use a short length of steel pipe on each side of the valve and adapt to the plastic pipe using couplings.

2.16 FLOATING PIPE

.1 Place adequate backfill to prevent floating of pipes.

.2 Remove and relay any pipes which have floated.

2.17 SETTING FITTINGS AND VALVES

.1 Install fittings and valves at the required locations.

.2 Install valve boxes plumb and support valve boxes to prevent the transmission of strain or shock to the valve.

.3 Set valve boxes flush with finished grades.

.4 Use galvanized metal harness where required.

.5 Provide Class II compacted backfill for 1.5 m radius all around valves.

.6 All valves located in sidewalks or roadways shall be screw type, encased within a protective PVC pipe sleeve, suitable in size, to allow for future adjustment of the valve.

2.18 SETTING HYDRANTS

.1 Install hydrants in the required locations and at the required directions.

.2 Set hydrants plumb with hose nozzles parallel or a right angles to the street centerline.

.3 Set hydrants with ground flanges above final curb and sidewalk grades.

.4 Provide gravel filter where hydrant barrels can be drained to the surrounding soil. Plug hydrant drains where ordered by the Engineer.

.5 Construct hydrant thrust blocks so that drains are not plugged.

.6 Provide Class II compacted backfill for 1.5 m radius all around hydrants.

2.19 PLUGGING OF DEAD ENDS

.1 Insert standard plugs into the bell ends of fittings or pipe bells. Place caps over spigot ends of fittings and pipes.

.2 Construct concrete thrust blocks for all caps and plugs as detailed on drawings.

.3 Tie plugs and caps to fittings using galvanized clamps and galvanized tie rods.

2.20 THRUST RESTRAINT AND ANCHORAGE

.1 Thrust restraint is required at changes in directions as at tees, bends and crosses; at changes in size; at stops; and at valves and hydrants.

.2 Valves shall be anchored as follows:

Working Pressure	Size of Valve Requiring Anchor
Up to 700 kPa	300 mm and up
700 kPa to 1000 kPa	200 mm and up
1000 kPa to 1380 kPa	all sizes

.3 Anchor valves as detailed on the drawings.

.4 For fittings, and stops in PVC, AC and ductile iron pipe provide concrete thrust blocks as shown on the drawings.

.5 Place concrete thrust blocks against solid ground with a minimum bearing area as shown on the drawings or as requested by the Engineer.

.6 Use concrete with a minimum compressive strength of 25 MPa.

.7 Pour the concrete in a manner that will leave pipes and fittings accessible for repair.

.8 For fittings and stops in concrete pressure pipe, construct thrust blocks in accordance with the drawings. If thrust blocks cannot be constructed or if the Engineer orders, construct tied joints in accordance with the manufacturer's recommendations for the type of pipe joint being used.

.9 Where solid backing is not available for PVC, Ductile Iron or Asbestos - Cement pipe fittings provide galvanized tie rods and galvanized pipe clamps in lieu of reaction blocks.

.10 Anchor pipes on slopes in accordance with details shown on the drawings.

2.21 HYDROSTATIC TESTING - GENERAL

.1 The Contractor shall supply all testing equipment and personnel to perform hydrostatic tests.

.2 Personnel shall be qualified to operate testing equipment and testing equipment shall be approved by the Engineer. Test pumps shall be motor driven and shall be complete with pressure gauges. An approved pressure recorder shall be provided to continuously record line pressure over a 24 hour period.

.3 The Contractor shall advise the Engineer 24 hours in advance of filling the line for testing.

.4 Testing shall be in accordance with regulations of the Occupational Health and Safety Act, and in accordance with Alberta Environment regulations.

.5 Testing shall not be done under winter conditions unless the line can be safely drained or immediately placed in operation.

2.22 PRESSURE TEST

.1 Pressure test after backfill in the pipe zone is complete and concrete thrust blocks are cured but before pipe joints are covered.

.2 Apply hydrostatic pressure of 1½ times the operating pressure or 690 kPa whichever is the greater.

.3 Inspect all pipe joints for leakage.

.4 Repair leaks or replace defective pipes.

.5 Backfill pipe joints as specified after acceptance of the test.

2.23 LEAKAGE TEST

.1 Leakage tests shall be performed on all pressure pipe systems, including service connections, after backfilling is complete.

.2 Test in sections not exceeding 1000 m of main, or obtain the approval of the Engineer to test larger sections.

.3 Test procedures are similar for all types of pipe installed, however leakage allowances shall be in accordance with the specified allowance for each type of pipe.

.4 Fill the system with water and expel air. If necessary install temporary taps to expel air and plug these after testing is complete.

.5 Apply test pressure by means of a test pump with a measurable volume container, acceptable to the Engineer.

.6 Test pressures shall be:

  .1 Ductile iron pipe - two times operating pressure, but not above pipe design pressure. Minimum test pressure shall be 1.25 times operating pressure, at the highest point in the system.

  .2 Asbestos cement pipe - two times the operating pressure at the lowest part of the system or the class designation of the pipe plus 50 percent, whichever is less.

  .3 Concrete pressure pipe - 1.25 times the operating pressure at the lowest part of the system or the rated pressure class of the pipe, whichever is less.

  .4 Polyvinyl Chloride pipe - 1.50 times the operating pressure at the lowest part of the system or the rated pressure class of the pipe, whichever is less.

  .5 Steel pipe - two times the operating pressure but not above pipe design pressure.

  .6 Polyethylene pipe - 1.50 times the rated pressure of the pipe or two times the operating pressure, whichever is less.

  .7 Do not vary test pressures more than 5 psi.

  .8 Do not apply test pressures in excess of two times the rated pressure of gate valves and hydrants.

  .9 Do not apply test pressures in excess of the rated pressure of butterfly valves.

.7 Maintain test pressures for a duration of two hours.

.8 Repair and test until leakage is within the specified limits.

.9 The results of all water pressure and leakage tests will be forwarded to the County prior to issuance of the Construction Completion Certificate. The results will be recorded and submitted using the form at the end of this section.

2.24 LEAKAGE ALLOWANCES - CONCRETE PRESSURE PIPE, DUCTILE IRON AND PVC PIPE

.1 Allowable leakage will be determined by the Engineer using the formula

$L = \frac{ND\sqrt{P}^*}{32046}$ Ductile Iron and Concrete Pressure Pipe

$L = \frac{ND\sqrt{P}^*}{128,275}$ for PVC pipe

where L = allowable leakage in litres per hour

N = number of joints in the test section

D = nominal pipe diameter in millimeters

P = square root of the test pressure in kPa*

.2 The number of joints is estimated from the total length of pipe installed plus 1 joint allowance for each water service connection.

.3 An additional allowance is made when testing against closed metal seated valves. This allowance is 0.0012 litres per hour for each millimetre if nominal valve size.

2.25 LEAKAGE ALLOWANCES - POLYETHYLENE PIPE, STEEL PIPE

.1 No leakage is allowed for a fused polyethylene joint, or a welded steel joint.

.2 The number of joints in the test section shall be counted as 1 joint for each service connection and 1 joint for each flanged joint in the section.

.3 Allowable leakage will be determined by the Engineer using the formula

$L = \frac{ND/P}{128,300}$

where L = allowable leakage in litres per hour

N = number of joints in test section

D = nominal pipe diameter in millimetres

P = the square root of the test pressure in kPa

.4 An additional allowance is made when testing against closed, metal seated valves. This allowance is 0.0012 litres per hour for each millimetre of nominal valve size.

2.26 CONDUCTIVITY TEST

.1 Perform a conductivity test to assure that an electric current can be passed through ductile iron mains.

.2 Perform the test after backfilling is complete.

.3 Supply all the equipment necessary, and obtain approval from the Engineer, for the method of conducting the test.

.4 Repair and retest until conductivity test is passed by the Engineer.

2.27 FLUSHING

.1 Flush watermains clean of all dirt.

2.28 DISINFECTION

.1 Before being placed in service, and before certification of completion by the Engineer, all new water systems, or extension to existing systems or valved section of such extensions, or any replacement in the existing water systems, or any exposed section of the existing systems, shall be disinfected in accordance with AWWA C651 continuous feed method. Chlorine concentration calculations and contact times are to be submitted to the County Engineer for approval.

.2 Upon completion of the disinfection, one bacteria sample is to be submitted for each 90 linear metres of watermain installed. Upon 48 hours notice samples are to be taken by County personnel and the watermain is to remain valved off until such time as the bacteria sample results are approved. The Contractor shall provide whatever assistance is necessary to permit sampling for these tests.

.3 The watermains shall be flushed after satisfactory testing, and the Contractor shall take all steps necessary to ensure that no unsterilized water or water contaminated with high levels of chlorine enters the public watermain system.

.4 If repairs are made on any section of pipe, disinfection shall be repeated.

.5 The Contractor shall pay all costs of retesting should the initial testing not be successful.

2.29 OPERATION

.1 Check the operation of all valves and hydrants in the presence of the Engineer.

.2 Mark locations of valves and other underground appurtenances with 50 mm x 100 mm stakes 0.9 m long driven 0.6 m into the ground at the property line opposite the valve. Marker stakes shall be painted red.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for gravity sewer lines for storm sewers, sanitary sewers and catch basin leads.

.2 The work of this section includes:

.1 Supply of pipe and jointing materials

.2 Installation and testing

1.2 RELATED WORK

.1 Trenching - Section 31 23 16.

.2 Manholes and Catch Basins - Section 33 05 13.

1.3 REGULATIONS

.1 The Standards and Guidelines for Municipal Wastewater and Drainage Facilities and the local Standard Specifications for Sewer Construction.

1.4 PIPE MATERIALS TESTING

.1 The Contractor shall, before the commencement of pipe laying, have two pieces of each size and type of sewer pipe tested to show compliance with the Specifications and provide test reports to the Engineer.

.2 Laboratories or agencies employed to test materials shall be independent testing agencies approved by the Engineer.

.3 The testing agency shall select specimens for testing.

.4 If the samples tested do not meet the specifications, additional testing will be required.

.5 The Engineer may select samples for testing and the Contractor shall pay all transportation, testing and materials costs for initial tests and for extra tests required.

.6 Materials supplied in this section are in accordance with ASTM and CSA specifications.

.7 The Engineer may at any time require the Contractor to produce certification by an independent testing agency that materials used conform to the specified standards.

.8 All concrete pipe shall be marked with the date of manufacture.

1.5 HANDLING OF PIPE & FITTINGS

.1 Handle pipe and appurtenances with approved equipment to prevent damage.

.2 Pile pipe in accordance with manufacturer's recommendations.

1.6 IN-PLANT VACUUM TEST

.1 All concrete pipe with confined O-ring joints shall be vacuum tested at the plant. The Contractor shall pay for in-plant vacuum tests.

.2 Each pipe section to be tested to a vacuum of 300 mm of mercury.

.3 Allow the vacuum to stabilize and hold the test for 20 seconds with no more than 2.5% loss.

.4 Pipe not passing the test shall be rejected and pipe passing the test shall be marked "air tested."

1.7 EXTERNAL LOAD CRUSHING STRENGTH TEST

.1 One pipe length shall be tested for each 500 metres of pipe supplied.

.2 Testing: to ASTM C497-M-86 - Method 4 External Load Crushing Strength by the 3 Edge Bearing Method.

.3 Tests shall be performed in the presence of the Engineer and shall be paid for by the Contractor.

1.8 QUALITY ASSURANCE

.1 Refer to Section 01 45 00 Quality Control.

.2 Submit to the Engineer a list of sources of materials including sand, gravel and concrete.

.3 Provide samples, test results, sieve analyses and reports for preliminary approval of materials.

1.9 QUALITY CONTROL TESTING

.1 Refer to Section 01 45 00 Quality Control.

.2 Moisture density curves: to ASTM D698-78.

.3 Sieve analyses: to ASTM C136-84a.

.4 Field densities: to ASTM D2167-84 or to ASTM D2922-81.

.5 Minimum quality control test frequencies specified as follows are the minimum number required. The Contractor shall perform as many tests as are necessary to ensure that the

Work conforms to the requirements of the Contract regardless of the minimum number required.

PART 2 - PRODUCTS

2.1 SEWER PIPE

.1 Non-reinforced Concrete - conforming to ASTM C14M-82 made with Type 50 cement.

Type of joint-Bell and Spigot

1. Mortar type.

2. ASTM C443M-85a - rubber gasket.

.2 Reinforced Concrete - conforming to ASTM C76M-86 or C655, made with Type 50 cement, with concentric reinforcing.

.3 Type of joint - Tongue and Groove Mortar Type

.4 Polyvinylchloride - PVC plastic gravity sewer pipe with rubber gasket joints, conforming to ASTM D3034-85b. Pipe dimension ratio - SDR 35, or as shown on the drawings. PVC will be allowed for storm sewer mains and leads up to a maximum of 375 mm diameter. SDR 28 for 100 and 150 mm and SDR 30 for 75 mm Weeping Tiles Services.

.5 Ultra Rib PVC pipe or CSA approved equal alternative will be permitted.

2.2 CATCH BASIN LEADS

.1 Conform to the requirements for sewermain.

2.3 CEMENT MORTAR

.1 Cement mortar for pipe joints, manhole and catch basin construction shall conform to the following mix.

1 part Portland Cement Type 50 Sulphate Resistant

1 1/2 parts clean sharp sand

Water to provide workability

.2 In freezing weather heat sand, cement and apply mortar hot. Protect joints from freezing until mortar has set.

2.4 PIPE BEDDING AND BACKFILL IN THE PIPE ZONE

.1 Sand, complying with the following gradation:

Sieve Size	Percent Passing
9.5 mm	100
4.75 mm	90 - 100
150 micro-m	20 max.

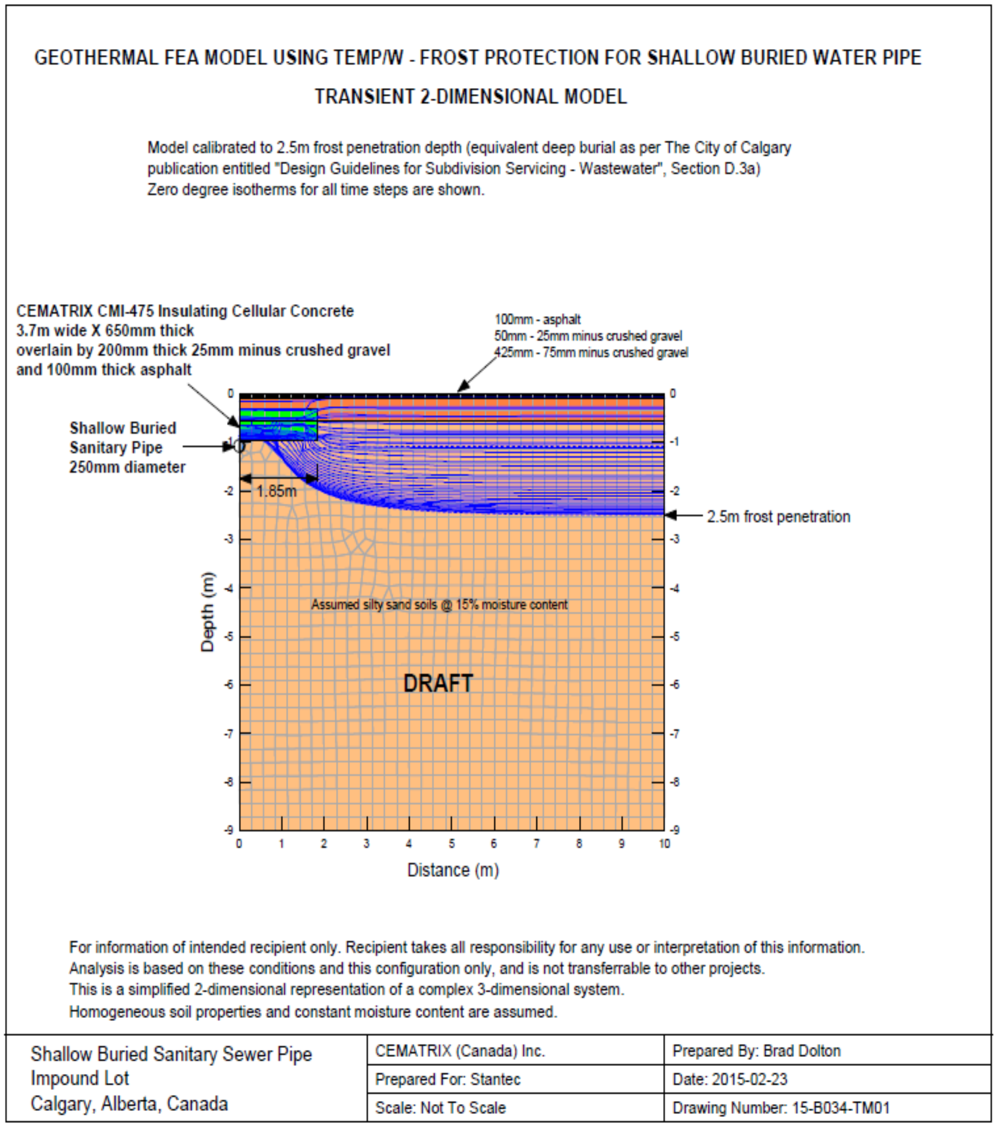
.2 Gravel, complying with the following gradation:

Sieve Size	Percent Passing
20 mm	100
12.5 mm	60 - 96
5.0 mm	37 - 76
2.0 mm	26 - 60
400 micro-m	11 - 41
160 micro-m	6 - 21
63 micro-m	2 - 10

.3 Concrete for Class A bedding shall conform to CAN3-A23.1-M77, Type 50, Sulphate Resistant, 25 MPa after 28 days, slump 75 mm.

2.5 Cematrix for shallow buried sewer pipe

1. Drawing PDF



PART 3 - EXECUTION

3.1 TRENCH INSPECTION

.1 Inspect the trench for clearance and grade to ensure that pipes can be properly laid to design grades.

.2 Inspect the trench bottom to ensure that the pipe has acceptable foundations.

3.2 PIPE INSPECTION

.1 Inspect pipe for defects, immediately before lowering into the trench.

.2 Do not install any pipe earlier than 7 days after the date of manufacture.

3.3 ALIGNMENT AND GRADE

.1 Lay pipes to the alignment and grade shown on the drawings.

.2 Erect at least four batter boards over the trench at intervals not exceeding 15 m.

.3 Mark the centreline of the pipeline on batter boards and maintain alignment by using a wire or string line and plumb bob.

.4 In lieu of batter boards maintain alignment and grade by laser equipment operated by a qualified technician.

3.4 ALIGNMENT TOLERANCE

.1 The centreline of the pipe shall not be more than 100 mm off the given line.

.2 Where the pipeline alignment is straight from manhole to manhole, one must be able to see through the pipe from manhole to manhole.

.3 Deflections at joints shall not exceed those recommended by the manufacturer.

.4 Where precast bends are used at centreline deflections, the maximum allowable deviation from the design centreline is 300 mm which shall be maintained throughout the distance to the next deflection.

.5 Provide short pipe sections as necessary to meet the above conditions.

3.5 GRADE TOLERANCE

.1 The invert of the sewer main shall not deviate from the grade given by an amount equal to 6 mm plus 10 mm per m of diameter of the sewer pipe.

.2 All pipes shall be laid sloping in the desired directions, with no reversed grades on any pipe lengths.

3.6 TRENCH WIDTHS

.1 Widths of trenches in the pipe zone shall be such that pipes can be laid and jointed properly, and backfill placed and compacted properly.

.2 Trench walls shall be vertical to 300 mm above the top of the pipe or to the maximum height permitted by safety regulations and the width at this location shall not exceed the maximum.

.3 Maximum width - Single Pipe, as shown on drawings, or

  .1 750 mm diameter pipe or less - outside diameter of pipe plus 600 mm.

  .2 Pipes larger than 750 mm diameter - outside diameter of pipe times 2 or as detailed.

.4 Maximum width - Multiple pipes, as shown on drawings, or

.1 750 mm diameter pipe or less 300 mm between pipes plus 300 mm each side of outside pipes or as detailed.

.2 Pipe larger than 750 mm - 300 mm between pipes and 400 mm outside of pipe over 750 mm; 300 mm outside of pipe under 750 mm or as detailed.

3.7 PIPE BEDDING

.1 Prepare the pipe bedding in accordance with the drawings and the following specifications.

.2 Class A - 25 MPa concrete bedding placed the full width of the trench to the depth shown on the drawings. Do not backfill concrete bedding until it is capable of supporting backfill loads.

.3 Class B - sand or approved gravel bedding material placed the full width of the trench and compacted to 95% of the maximum density as determined by the Standard Proctor Compaction Test.

.4 Class C - sand or selected native material compacted to 90% Standard Proctor Density.

.5 Provide bell or coupling holes and support the pipe uniformly and continuously throughout its length. Ensure pipe haunches are properly bedded.

3.8 LOWERING PIPE AND ACCESSORIES INTO TRENCH

.1 Use implements, tools and facilities satisfactory to the Engineer, and use care to prevent damage to pipe and material. Do not drop pipe or materials into the trench.

.2 Cover pipe ends if necessary to keep clean.

3.9 PIPE LAYING AND JOINTING; GENERAL

.1 Lay pipe with bells upgrade and proceed upgrade.

.2 Produce a smooth, uniform invert.

3.10 CEMENT MORTAR JOINTS - BELL AND SPIGOT PIPE

.1 Saturate hemp or oakum gaskets with neat cement, and place around the spigot end of the pipe.

.2 Gasket diameter shall be not less than 19 mm and shall be lapped at the top.

.3 Insert spigot end of pipe and drive in.

.4 Fill the joint with cement mortar and ram the gasket solidly and tightly into the annular space using suitable caulking tools.

.5 Overfill the joint with mortar and level off to a 45° angle to the outside of the pipe.

.6 Set two pipes ahead of the joint, before mortaring the joint.

3.11 CEMENT MORTAR JOINTS - TONGUE & GROOVE

.1 Pack the upper half of the tongue and the lower half of the groove with cement mortar, and insert tongue in groove.

.2 Apply sufficient end pressure to squeeze some of the mortar out of the joint.

.3 Remove excess mortar and fill voids on the inside of the pipe.

.4 Set two pipes ahead of the joint and finish the outside of the joint with a band or bead of mortar over the joint.

3.12 RUBBER GASKET JOINTS - CONCRETE PIPE

.1 Clean and check the sealing surfaces to ensure that they are smooth, concentric and free from imperfections that might affect the sealing efficiency of the gasket.

.2 Install the gasket on the tongue in accordance with the manufacturer's recommendations.

.3 Lubricate sliding surfaces and couple pipes immediately.

.4 Use only approved equipment to pull pipes together.

3.13 RUBBER COUPLING - PLAIN END PIPE

.1 Clean and inspect pipe ends and cut if necessary.

.2 Install the rubber coupling on previously laid pipe and tighten the nut so that the coupling will not move.

.3 Insert the next pipe so that the pipe ends are flush against the stop ring.

.4 Tighten the second nut so that the joint is snug.

.5 Align the pipes and set firmly in place.

.6 Tighten the nuts alternately in accordance with the manufacturer's instructions until the joint is complete.

3.14 POLYVINYL CHLORIDE

.1 Clean and check the pipe ends, and wipe the rubber ring clean.

.2 Wipe around the spigot end of the pipe with a clean, dry cloth.

.3 Lubricate the spigot end of the pipe, covering the entire spigot end circumference. Apply the coating evenly by hand, cloth, pad, sponge or glove to the equivalent of a brush coat of enamel paint.

.4 Insert the spigot end into the bell so that it is in contact with the rubber ring. Keep the pipes in alignment and brace the bell end to prevent movement. Push the spigot end in until the reference mark on the spigot end is flush with the end of the bell.

3.15 CONFINED O-RING JOINTS - CONCRETE PIPE

.1 Clean and check the sealing surfaces to ensure that they are smooth, concentric and free from imperfections that might affect the sealing efficiency of the gasket.

.2 Install the gasket on the tongue in accordance with the manufacturer's recommendations.

.3 Lubricate sliding surfaces and couple pipes immediately.

.4 Use only approved equipment to pull pipes together.

.5 Maximum horizontal joint separation between pipes measured from inside shall be 19 mm.

3.16 BACKFILLING IN THE PIPE ZONE

.1 The pipe zone is defined as that part of the trench from the pipe bedding to 300 mm above the top of the pipe, or above the top of the highest pipe in a combined trench.

.2 Backfilling in the pipe zone shall be in accordance with the drawings and the following specifications.

.3 Class A – bedding pipe in which the lower part of the pipe is set in non-reinforced or reinforced concrete of suitable thickness under the lower part of the pipe extending upwards on each side of the pipe for a proportion of its height.

.4 Class B - Backfill with sand or with selected native soil deposited uniformly in the trench at both sides of the pipes for the full width of the trench. Compact in layers to 95% of the maximum density as determined by the Standard Proctor Compaction Test, until the compacted backfill is 300 mm above the top of the pipe. Compact under and around pipe and pipe joints.

.5 Class C - backfill with sand or selected native soil deposited uniformly in the trench at both sides of the pipe for the full width of the trench. Compact in layers to 90% of the maximum density as determined by the Standard Proctor Compaction Test, until the compacted backfill is 300 mm above the top of the pipe. Compact under and around pipe joints.

.6 Frozen material shall not be used for backfill in the pipe zone.

.7 Where conditions are such that unfrozen native material is not obtainable, provide unfrozen sand at the Contractor's expense.

3.17 CLEANING PIPES

.1 Cover open ends of pipes using precast caps or steel discs before leaving the unfinished work at any time.

.2 Remove all foreign material from the pipe.

.3 Take precautions to prevent debris from new sewers from entering existing systems.

.4 Flush all pipes clean by a method approved by the Engineer and dispose of all water away from existing sewers.

3.18 CATCH BASIN LEADS

.1 Lay catch basin leads in accordance with the specifications for sewermain, above, using Class B bedding.

3.19 INSPECTION AND TESTING - GENERAL

.1 The Contractor shall provide materials, equipment and labour as required to inspect and test gravity sewer pipes in the presence of the Engineer.

.2 Inspection and testing procedures shall be carried out in conformance with the Safety Regulations of Occupational Health and Safety.

.3 Sewers not passing inspections and tests or having obstructions, breaks or any other defects shall be repaired at the Contractor's expense, and shall be re-inspected and re-tested, at the Contractor's expense.

3.20 VISUAL INSPECTION

.1 All installed sewers shall be visually inspected by the Contractor and the Engineer to determine if there are obstructions, breaks or misalignments of pipes.

.2 Gravity sewers, which are designed to be straight, shall be tested by light testing from manhole to manhole; and variations in line, grade and any other faults shall be recorded.

.3 Where light testing cannot reveal the extent of problems the Contractor shall have a television inspection done at the Contractor's expense. Television inspection shall be in accordance with Section 33 01 30 Television Inspection.

.4 The costs of visual inspection are considered incidental to the unit prices bid for gravity sewer installation.

3.21 WALK THROUGH INSPECTION

.1 A "walk through" inspection is required on gravity sewers 1050 diameter and larger.

.2 The inspection shall be by a representative of an independent testing agency. A representative of the Contractor and the Engineer may be in attendance.

.3 The inspection shall be completed as a work report, in log form, which shall show locations of leaks or faults such as open joints, broken or cracked pipe, presence of debris, or dirt or other obstructions; infiltration, water depths and any other points of significance. The location shall show distances away from reference manholes; and the position of leaks or faults as referenced to the crown of the pipe using clock face notation.

.4 All service connections shall be located and the condition of the connections shall be noted.

.5 At least one photograph shall be taken for each 25 metres of sewermain to show representative pictures, plus additional pictures of deficiencies. Photographs shall be referenced to the logs.

.6 All sections of pipes and manholes shall be clearly identified on the report. Use manhole numbers and street names. Record type of pipe, joint lengths, flow directions, flow depths, manhole depths, dates, names of inspectors and information regarding camera equipment used.

.7 Submit 3 copies of the final report complete with all photographs, to the Engineer, within 2 weeks of the date of inspection.

.8 Walk through inspections shall be paid for at the unit prices bid in the Tender.

3.22 TELEVISION INSPECTION

.1 Television Inspections shall be in accordance with Section 33 01 30 Television Inspection.

.2 Television inspections shall be performed on all sections of sanitary and storm greater than 150 mm.

.3 Television inspections for sewermains, they are an incidental cost item and all costs for television inspections shall be bid into the original unit pipe price for supply and installation.

.4 Where television inspections are ordered in lieu of unsuccessful light testing, the inspections shall be performed at the Contractor's expense.

3.23 TESTING OF GRAVITY SEWERS

.1 After sewer mains have passed inspection and are cleaned, leakage tests shall be performed by the Contractor, if ordered by the Engineer. The Engineer will determine if the test shall be an infiltration or exfiltration test.

.2 The Contractor shall provide water, materials, equipment and labour as required. Equipment shall include plugs, meters or weirs, and other measuring equipment that is acceptable to the Engineer; to measure the height of the groundwater table and to measure exfiltration or infiltration.

.3 The Engineer will determine the lengths of sections to be tested.

.4 Infiltration testing shall be performed by plugging the upstream end of the test section, and measuring flow at downstream end. Test duration shall not exceed 4 hours.

.5 Exfiltration testing shall be performed by plugging both ends of the test section and filling the test section to provide a hydrostatic head of 600 mm above the top of the highest part of the section.

.6 The head of water on the pipe shall be taken as the height of water above the groundwater level.

.7 Test duration shall be 1 hour minimum, 6 hours maximum.

.8 Leakage allowances shall be determined as follows:

Pipe Material	Leakage Allowance
PVC	Infiltration Test: 5.0 L/day/mm dia/km is allowable with no allowance for external hydrostatic head. The groundwater table is to be above pipe crown at all locations of the test section. Exfiltration Test: 5.0 L/day/mm dia/km is the combined allowable exfiltration from pipe and manholes with hydrostatic head at the high manhole to be a minimum 0.6 m higher than crown of pipe or groundwater table, whichever is higher. The water level is not to exceed 7.6 m above top of pipe at low manhole. Low Pressure Air Test: The following formula is to be used to calculate the minimum required test time: T = 1.02 DK/Q Where: T = shortest time, in seconds, for air pressure to drop from 24.13 KPa (3.5 psi) to 17.24 KPa (2.5 psi) K = 0.054 DL, but not less than 1.0 D = Pipe diameter, metres L = Length of pipe being tested, metres Q = 0.00046 m^3/min/m^2 of internal surface (0.0015 ft^3/min/ft^2) The total leakage from any test section shall not exceed 580 m^3/min (6250 ft^3/min).
Concrete	Infiltration Test: 20.0 L/day/mm dia/km is allowable with average depth of groundwater a minimum of 0.6 m above crown of pipe. Where the average head of groundwater is 1.8 metres or more above the crown, the infiltration limit is increased by the ratio of the square root of the actual head to a base head of 1.8 metres. Exfiltration Test: 20.0 L/day/mm dia/km is the combined allowable exfiltration from pipe and manholes when average head on the test section is 0.9 metres above crown of pipe or groundwater table, whichever is higher. Exfiltration limit is increased by the ratio of the square root of the actual head to a base head of 0.9 metres when the average head on the test section is greater than 0.9 metres above crown of pipe or groundwater table, whichever is higher. Low Pressure Air Test:

Same as for PVC pipe except Q = 0.00009 m^3 of internal surface (0.003 ft^3/min/ft^2).

.9 Sewer main test sections having leakage in excess of the allowable shall be replaced or repaired as necessary to pass the test.

3.24 HYDROSTATIC PRESSURE TEST

.1 The acceptability of the concrete pipe joints shall be determined by hydrostatic pressure test, in the presence of the Engineer.

.2 The test shall be performed in accordance with requirements in Section 9 - Performance Requirements for Joints, ASTM C443M-85a.

.3 Pipes for the test shall be selected at random.

.4 Minimum one test shall be performed per 1000 m of sewerline.

.5 The Contractor shall pay for all hydrostatic pressure tests.

END OF SECTION

PART 1 - GENERAL

1.1 DESCRIPTION

.1 This section specifies requirements for water and sewer service connections from the mains to the property line.

1.2 RELATED WORK

.1 Trenching - Section 31 23 16.

.2 Gravity Sewers - Section 33 19 00.

.3 Pressure Pipe - Section 33 18 00.

1.3 REGULATIONS

.1 The Standards and Guidelines for Sewer Construction, along with the Municipal Water Supply, Wastewater and Storm Drainage Facilities, Standards and Approvals Division, of Alberta Environment apply to the work of this section.

1.4 MATERIALS TESTING

.1 Testing laboratories or agencies employed to test materials or installation shall be independent testing agencies approved by the Engineer.

.2 Materials supplied in this section are in accordance wit AWWA, ASTM and CSA Standards.

.3 The Engineer may at any time require the Contractor to produce certification by an independent testing agency that materials used conform to the specified standards.

1.5 HANDLING OF PIPE AND ACCESSORIES

.1 Pipe and accessory materials shall be unloaded and stored at the site by the Contractor, with care to prevent damage.

.2 Store materials so that they are kept clean.

.3 Store materials in accordance with the manufacturers’ recommendations.

PART 2 - PRODUCTS

2.1 WATER SERVICE MATERIALS

.1 Copper Pipe

- .1 Type K soft copper - ANSI/AWWA C800-89.

- .2 Couplings - standard brass compression type.

.2 Cross-linked Polyethylene Water Pipe (PEX)

.1 Rehau (Municipex), Wirsbo (Aquapex) or approved equal.

.3 Corporation Cocks

.1 Copper flange to Mueller thread equal to Mueller A220 (AWWA C-800-89) without thaw out connector.

.4 Curb Stop

.1 Copper to copper curb valve - no drain - Mueller Oriseal H15204 or equal.

.5 Coupling

.1 Mueller A 319.

.6 Service Boxes

.1 Extension type for maximum extension 3 m equal to Mueller A714 with Mueller A808 rib cover.

.7 Service Clamps

.1 Mueller Servi Seal 500 Series or approved equivalent alternative.

2.2 SEWER SERVICE MATERIALS

.1 Service Pipe

.1 Polyvinyl chloride pipe - SDR 28 conforming to ASTM D3034-85b, minimum pipe stiffness 320 kPa. Conform with CAN/CSA-B182.1-87.

.2 Sewer Service Saddles

.1 For PVC use Rockwell type saddles.

.3 Polyvinyl Chloride Fittings

.1 Tee Branches, bends, plugs, and saddles conforming to CSA-B182.1-87.

2.3 BEDDING

.1 Sand conforming to the specification under trenching.

2.4 CONCRETE

.1 Compressive strength 25 MPa at 28 days, sulphate resistant cement type 50.

PART 3 - EXECUTION

3.1 TRENCH INSPECTION

.1 Check trench bottom for stability.

.2 Remove unstable soil and replace with compacted pit-run gravel, or washed rock if ordered in writing by the Engineer.

3.2 INSPECTION OF MATERIALS

.1 Inspect for defects immediately before lowering into the trench.

.2 Clean all pipes, fittings and valves before installation.

3.3 ALIGNMENT AND GRADE

.1 Lay service pipes to the required alignment and grade from the main to the street property line.

.2 Lay service pipes in a common trench wherever possible. Water service shall be on the right side of the sewer service when viewed from the street looking towards the property.

.3 Provide 2.6 m minimum cover.

.4 Minimum grades for sewer service pipes shall be:

  .1 150 mm diameter pipe - 20 mm per m

3.4 TRENCH WIDTH

.1 Minimum - sewer service pipe diameter plus 600 mm, and wide enough so that the pipes can be laid to the alignment and depth required.

3.5 BORED OR AUGERED SERVICES

.1 Bore holes shall be large enough to pass service pipes through without disturbing joints.

3.6 INSTALLATION - GENERAL

.1 Prepare pipe bedding in accordance with drawings.

.2 Provide bell or coupling holes for sewer pipe and support the pipe throughout its length, uniformly and continuously.

.3 Use only implements, tools and facilities satisfactory to the Engineer, and as recommended by the manufacturer of the material.

.4 Cover open ends of installed pipe when pipe laying is not in progress.

3.7 INSTALLATION - WATER SERVICE CONNECTION

.1 Drill and tap watermains under pressure using a tapping machine.

.2 Maximum sized tappings permitted without the use of service clamps are:

 .1 100 mm main - 19 mm tapping

 .2 150 mm main - 19 mm tapping

 .3 200 mm main - 25 mm tapping

.3 Where larger sizes are required use double strap service clamps, or multiple corporation stops spaced 300 mm apart and staggered around the pipe.

.4 Tap into the upper half of watermain and incline upward at 45°.

.5 Form a gooseneck in the horizontal plane at the corporation stop.

.6 Lay copper pipe slack in the trench.

.7 Curb Stops and Services Boxes

 .1 Where front yard gas servicing is provided, curb stops shall be located 0.15 m from the back of the gas easement line. Where there is no front yard gas servicing, curb stops shall be located 2.35 m inside the property line or as noted on the drawings.

 .2 Support curb stops on a 50 mm concrete brick base.

 .3 Set the services box plumb and adjusted to grade.

 .4 Mark the location with a 50 mm x 100 mm x 910 mm painted marker, set from the invert end of the service extending at least 0.50 m above the ground.

3.8 INSTALLATION - SEWER SERVICE CONNECTION

.1 Connection to a main sewer line will be by means of a wye fitting. A tee fitting will be allowed provided they discharge into the top half of the main.

.2 Saddles will only be allowed for connection to an existing main. Tap the sewer main in the upper half and install the service saddle neatly and without damage to the main. Connect the saddle as detailed, leaving no protrusion into the sewer main.

.3 Install sewer risers where the main depth exceeds 4.5 m and where requested by the Engineer. Risers will be installed to within 3.60 m of the finished surface.

.4 Lay sewer service pipe and joint in accordance with the pipe manufacturers' instructions and in accordance with 33 19 00 Gravity Sewers.

.5 Keep the sewer service pipe clean and plug the line a minimum of 0.15 m from the back of the gas easement line or, if front gas servicing is not provided, 2.35 m inside the property line or as noted on the drawings.

3.9 BACKFILLING IN THE PIPE ZONE

.1 Backfill, using Class B Backfilling in the pipe zone, as specified under trenching.

3.10 WATER SERVICE TESTING

.1 The water service pipe will be included in the leakage test. Each 19 mm service connection will be counted as one joint in calculating allowable leakage.

.2 If thaw out wires are installed, test each service for conductivity.

END OF SECTION

1 General

1.1 REFERENCES

.1 ASTM International:
- .1 ASTM A325-14: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
- .2 ASTM A325M-14: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength [Metric].
- .3 ASTM D698-12e2: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).

.2 CSA Standards:
- .1 CSA-A3000-13: Cementitious Materials Compendium.
- .2 CAN/CSA-A23.1-14/A23.2-14: Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .3 CAN/CSA A23.3-14: Design of Concrete Structures.
- .4 CSA-B72-M1987 (R2013): Installation of Lightening Rods
- .5 CSA-C22.1-12: Canadian Electrical Code, Part 1
- .6 CSA-G4-15: Steel Wire Rope for General Purpose and Mine Hoisting and Mine Haulage
- .7 CSA-G12-14: Zinc Coated Steel Wire Strand
- .8 CAN/CSA-G30.18-09 (R2014): Billet-Steel Bars for Concrete Reinforcement.
- .9 CAN/CSA-G40.20-13: General Requirements for Rolled or Welded Structural Quality Steel.
- .10 CAN/CSA-G40.21-13: Structural Quality Steels.
- .11 CAN/CSA-S16-14: Design of Steel Structures.
- .12 CSA S37-13: Antenna Towers and Antenna Supporting Structures.
- .13 CSA S269.3: Concrete Formwork.
- .14 CSA W47.1-09(R2014): Certification of Companies for Fusion Welding of Steel.
- .15 CSA W48-14: Filler Metals and Allied Materials for Metal Arc Welding.
- .16 CSA W55.3-08(R2013): Certification of companies for resistance welding of steel and aluminum.
- .17 CSA W59-13: Welded Steel Construction (Metal-Arc Welding).
- .18 CSA W178.1-14: Certification of Welding Inspection Organizations.
- .19 CSA W178.2-14: Certification of Welding Inspectors (Developed in cooperation with the Canadian Welding Bureau).
- .20 CSA Z259.16-04 (R2014): Design of Active Fall Arrest Systems.
- .21 CSA Z259.13-04 (R2014). Flexible Horizontal Lifeline Systems.
- .22 CSA Z259.2.2-14: Self Retracting Lifelines.

.3 Canada Labour Code

.4 Health and Welfare Canada

.5 Safety Code 6Limits of Exposure to Radio-Frequency Fields at Frequencies from 10 kHz-300kHz.

.6 Provincial Occupational Health & Safety Act and Regulations

.7 Codes:
 .1 ABC: Alberta Building Code 2014.
 .2 NBCC: National Building Code of Canada 2010.

.8 EIA/TIA 222: Structural Standard for Antenna Supporting Structures and Antennas.

.9 Canadian Aviation Standards Document CARs 621.19 Tower Obstruction Markings

.10 RCMP Safety Regulations.

.11 RCMP Standards and Guidelines for Communication Sites.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Provide shop drawings indicating plans, elevations, details, connections, materials, lateral supports, concrete foundations, tower details, antennas, electrical connections, conduits, grounding, anticlimb panels, lightning protection, fall arrest equipment, top and all other details and requirements to completely describe antenna tower and accessories for this project.

.3 Shop drawings are to be signed and sealed by a Professional Engineer registered in the Province of Alberta.

1.3 DESIGN REQUIREMENTS

.1 Completely design and engineer antenna tower and accessories. Coordinate all design requirements with RCMP Tower and related structures guidelines. Design tower to be minimum 80'-0" high.

.2 Engage a Professional Engineer registered in the Province of Alberta, to design the complete antenna tower, including concrete base, tower, lateral supports, and all electrical and antenna components as required for a complete installation.
 .1 The tower design engineer shall have a minimum of 5 years of communication tower design experience and shall be prepared to fully support all assumptions made with regard to the tower design. These assumptions shall be clearly stated on correspondence, which accompanies the design drawing, complete with back up information, calculations, and the like. The design engineer of record shall be clearly stated on all shop drawings.

.3 Design antenna tower to withstand all superimposed loading, including wind loads for the Elk Point area as outlined in the Alberta Building Code 2014 and National Building Code of Canada 2010 and based on the Qh site specific profile provided by Environment Canada.

.4 Design Ice Load: design the tower for a minimum ice loading of 50 mm of radial ice on all exposed surfaces, including members, guys, all attachments, and antenna components. The density of the ice shall be taken as 900 kg/m^3.

.5 Base the loading imposed on the tower by transmission lines and auxiliary lines - feeder lines, attached to it, on the actual dimensions of the lines as determined from the manufacturer's specifications.

.6 Design tower for a maximum twist / tilt not exceeding 1.5°. Maximum twist / tilt at each antenna level must be indicated on all preliminary and final tower designs.

.7 The value of Cd shall be taken as 1.5 for flat feeders and 1.0 for round feeders.

.8 Provide shielding of the transmission lines by the tower members, other feeders or attachments as required. When feeder lines are mounted on the inside of one face of the tower, shielding of the leeward lines may be considered, following the procedures outlined in "Commentary on Part 4 of ABC 2014". Shielding assumptions by the design engineer must be clearly stated, in writing, to the Departmental Representative.

.9 Take into consideration loading from auxiliary facilities and attachments such as ladders, fall arrest rails, rest and transfer platforms, antenna mounts, ice guards, feeder line supports, lighting and the like, in a similar fashion as to that of the transmission lines and feeders.

.10 Submit detailed design calculations to support tower and foundation designs.

.11 Design all foundations and anchors based on the attached Geotechnical Report.

.12 Design ice shields for all antennas, lights and photocells below the top mounted antenna. Take into consideration all loads imposed by all ice shields (both initial and future).

.13 Where requested by the Departmental Representative, the design engineer must provide additional information to verify design adequacy or respond to Technical Authority queries. This information shall be provided at the Contractor’s cost, in written form under the professional seal of the engineer of record.

.14 Design all antenna and electrical components to provide a 700 MHz base antenna and VHF base antenna and addition 700 for AFRRCS system expansion.

.15 Provide all bonding and grounding provisions conforming to CSA C22.1.

.16 Provide all Antenna Tx/Rx cables and the like.

1.4 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for antenna tower and equipment for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

2 Products

2.1 MATERIALS

.1 Concrete and reinforcing: as specified in Division 03.

.2 Steel requirements: to the requirements specified in Division 05 and as indicated on the reviewed shop drawings.

.3 Guy wires and supports: as detailed on the reviewed shop drawings.

.4 Antennas, electrical components and accessories: as detailed on the reviewed shop drawings.

.5 Fall Arrest equipment: as indicted on the reviewed shop drawings.

3 Execution

3.1 INSTALLATION

.1 Install antenna tower, concrete foundation, guy wires, antennas, electrical components and accessories, to locations indicated on the drawings and reviewed shop drawings.

.2 Install plumb and true to line to withstand all superimposed loading.

.3 Install fall arrest equipment in strict accordance with manufacturer’s requirements, and adjust as required for proper operation.

.4 Coordinate underground conduit pathways, with Division 26.

.5 Ensure that antenna tower and all electrical and antenna equipment operate properly.

3.2 FIELD QUALITY CONTROL

.1 Inspections:

  .1 Inspection and testing of tower, concrete, cables, and equipment will be carried out by testing agencies designated by Departmental Representative.
  .2 Contractor will pay for tests out of the Cash Allowance as specified in Section 01 21 00 - Allowances and Section 01 29 83 - Payment Procedures for Testing Laboratory Services.

END OF SECTION